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A MANUAL

OF

ANIMAL VACCINATION

PRECEDED BY

Considerations on Vaccination in General

BY

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PREFACE.

I PUBLISHED, in 1883, a "Treatise on Vaccine and Vaccination, Human and Animal,"* in which I discussed all the aspects of this important question, which engages to so great an extent those who concern themselves with the progress of hygiene in its relations to human prophylaxis.

In my preface, I justified as follows my interference in this matter:—

"For eighteen years, placed at the head of various institutions, official or otherwise, established for the purpose of animal vaccination in Belgium since the year 1865, I have vaccinated every year at least seven or eight hundred children, and distributed, at home and abroad, large quantities of lymph, animal and humanized, the destinies of which I have often been able to trace. So much for experience. My position and duties are recited on the title-page. As for my age, the century was but twenty years old when I was born."

This commencement, all personal as it is, is suggested to me by those words that Bousquet, whose name I shall frequently quote, has written in the preface to the second edition of his memorable work:—"In medicine, it is as a rule desirable to understand thoroughly the position and character of an author. His position, shows us the possibility of his having seen all he describes; his character, vouches for the fidelity of his narration.

* One volume 8vo, with a Lithographed Plate. Paris: J. B. Baillière et Fils. Brussels: Mme. Manceaux. 1883.

"A new book is announced. Acquaint yourself with the author: seek to know where he lives, the appointments he fills, the special sphere of his observations, the interest he takes in his art, the respect he enjoys amongst his fellow-citizens.

"What concerns me least is his age; not that experience is not sometimes the proof of good practice, but that if experience mean only a certain ability to do well, it is not years alone that give it. I grant, however, that, other things being equal, the favourable presumption should be attached to him that has most experience. With the physician, as with the traveller, he who can say *I have seen* is nearly always certain to be listened to with interest."

Ah, well! I have seen, and seen much.

The most recent doctrinal work on vaccination published in the French language is the "New Treatise on Vaccination and Varioloid Eruptions," by T. B. Bousquet. The last edition of this work is dated 1848.

Whoever concerns himself with this subject so serious and so important, knows the great value of this magnificent work, which honoured the Academy of Science and which has served as a guide to numerous generations of vaccinators.

Written in elegant and fluent style, full of ingenious ideas, remarkable for the scientific discussions which embellish it, "The New Treatise on Vaccination" deserves to have a long and honourable career.

Many maxims proclaimed by its eminent author have become axioms which no one even dreams of disputing.

During the thirty-five years since this work appeared, more than one of these axioms has, however, deserved to be questioned.

If general science progresses incessantly, why should not a practice based upon daily examples counted by millions, also progress? Jenner's method was scarcely fifty years old when Bousquet prepared his immortal work; it is now nearly twice as old. Then, the lymph posed as the chief problem, the question of the length of protection obtained by its use, perhaps the influence of its action upon the public health; perhaps, still further, even its prophylactic power. Thirty-five years more could but bring forward powerful facts for the elucidation of these various questions, and have indeed done so.

During the same time other advances have changed utterly the points of vantage whence, until then, one had viewed the prevention of small-pox. The labours of Chauveau and the discoveries of Pasteur have given substance to theories until then doubtful, and have similarly upset others. Vaccinology has benefited greatly by the improvements worked by science in the way of modern scientific positivism.

Then, a new method has come to take its place beside the traditional practice: lymph, termed *animal*, is put forward as the successor to Jennerian vaccine.

It is chiefly to bring this last method prominently forward that I have written my book. The discussion which I have given to questions relating to vaccination in general are only, so to speak, the framework of the picture—a framework become necessary by reason of the extreme importance given to the study of the prevention of infectious diseases, and especially of small-pox, by the knowledge recently acquired in the mode of attenuation and culture of germs. These developments have been favourably received, and in evidence I will quote the following letter, which, on the appearance of my work,

the scientist whose support should be to me more precious that that of any other, has written to me.

Here it is :—

"Arbois (Jura), *Sept.* 12, 1883.

"Dear Sir,

"During the academic year, the work of the laboratory keeps me so much employed that I have no time to read long-winded works, even those which I know must interest me greatly, so I put them aside for study during the vacations.

"That is what I have just done with your 'Treatise on Vaccination,' which, from one end to the other, is excellent for its clearness, for the perfect knowledge of the subject displayed, and for the place which you so judiciously give in it to modern discoveries and to the relations they hold to the questions of small-pox and vaccination, each of such great general and scientific interest.

"Be good enough to accept, my dear sir, with my most sincere thanks, the expression of the most devoted sentiments of "L. Pasteur."

In the present edition, written for the English medical world, and which I wish to devote particularly to the popularization of so-called *animal* vaccination, I have carefully cut short everything that had not directly to do with this special subject, limiting myself to some considerations, of which the explanation has appeared to be necessary to the development of my ideas, and to the knowledge of their practical application.

I have given considerable space to the study of the apparatus of vaccination. I trust the reader will not read about them without interest.

The Author.

GENERAL OBSERVATIONS ON VACCINATION.

INTRODUCTION.

1. Ever since vaccine has been known, it has been considered as a liquid, with special properties inherent to it. That is a mistake. Vaccine is a substance found in what is known as the vaccine-vesicle, free in the cells of which this vesicle is composed, or adherent to their circumference, or to the other structures found therein (sheaths of the hairs, &c.).

The vaccine-vesicle, in addition, is infiltrated with a serous fluid, which in man escapes directly an opening is made, carrying with it a certain number of the virus corpuscles.

These corpuscles are found in the papules of horse-pox or cow-pox, natural or artificial. Inoculated into the child, they give origin to papules with the same characteristics, and concealing in their turn an element similarly inoculable into the human species, the cow, and the horse; and which in either case is named *vaccine*.

Vaccine, whether it proceeds in a direct line from the horse or from the cow, possesses equally the same properties—it gives rise to characteristic vesicles, and when it has been inoculated into a subject, human, bovine,

or equine, confers immunity whether from small-pox or vaccination.

The small special bodies which are found both in the small-pox pustule and the vaccine-vesicle, are nowadays by common consent considered to be infectious, parasitic, vegetable organisms; the regularity of their form, their grouping, the constancy of their presence in all the stages of the eruption, their appearance in all (vaccine) lymph, of which they form the indispensable element of virus-bearing activity, and then the study of these bodies as compared with microbes—whose power of infection on the one hand, and parasitic nature on the other, are beyond question—justify this mode of regarding them.

These microbes, considered as the specific agents in small-pox and in vaccination, are small and perfectly spherical micrococci.

M. Gluge had already observed in vaccine-lymph the presence of crystals, which appeared to him sufficiently characteristic to enable him to establish microscopically the distinction between vaccine-lymph and all other pathological fluids;* but to Kleber belongs the honour of having first sought to demonstrate the nature of these translucent "cells," by endeavouring to separate them from the containing lymph by various filtration processes. He succeeded well enough in his attempts to prove that inoculation with lymph deprived of these "cells" gave no result. M. Chauveau, on his side, undertook some accurate experiments to establish the importance of these same elements, at a period when no one in

* "Anatomists Microscopische-Untersuchungen." Two vols.: the first appeared at Winden in 1838, the second at Jena in 1841. By Gluge. Vol. i. p. 67.

France dreamt of according to them the dignity of parasitic growths with an independent existence. The experiments of Chauveau had demonstrated similarly, in the most indisputable manner,* that vaccine-lymph deprived of these corpuscular elements loses all its virus-bearing properties.

It is not to be doubted that the *active cells*, perhaps the *crystals* of Gluge, are really a true, parasitic and infectious microbe: the advances made during the last few years in the recognition of these inferior organisms leaves us no longer the shadow of a doubt on the subject. At present no one has been able to cultivate these cells outside the body; even the most persevering attempts in this direction have failed. It is needless to remark, that if one were to succeed in cultivating the vaccine-microbe in a medium free from all possible suspicion, we should have made a great advance. However, this discovery is still among the events of the future.

Those who believe that horse-pox and cow-pox are only small-pox attenuated in its passage through the body of the horse or of the cow—and it is a belief with which we must deal hereafter—will dream, without doubt, of seeking the prophylaxis of small-pox in the attenuation of its own virus, not being able to find it in the cultivation of the vaccine-microbe in harmless media.

It is an idea which is already apparent, and which will gain ground.

2. The vaccine-microbe does not differ in its visible

* Chauveau, "Nature des Virus. Détermination Experimentale des Éléments qui constituent la prineipe virulent dans le pus varioleux et le pus morveux." Académie des Sciences de Paris, séanee du 24 Février 1868. (*Gazette hebdomadaire*, 13 Mars 1868, p. 165.)

physieal eharaeters from the small-pox microbe. However, it must have a structure differing in some points which eseape our means of investigation, sinee they give results not entirely similar.

Who can choose from among two poppy-seeds that which will give birth to a red flower, or that from which a white flower will develop?

The kernel of the sweet almond, which gives us a nourishing fruit, is indistinguishable to the eye from the kernel of the bitter almond, whieh eontains the most potent poison; *no one, however, would dream, from the external resemblance of the two nuts,* of insisting upon their identity; and no one, for all that, would think of doubting that a differenee must exist in their molecular arrangement. These differenees indeed are infinitely small, but it is our means of investigation that are deficient. The development of these methods may enlighten us to-morrow, perhaps; perhaps at some more distant period; perhaps never. Meanwhile, here is what is known of these bodies, which are so small that with the most powerful enlargements of our best instruments they only look to us like the *points* of eommon letter-press.

Klebs gives the following deseription of them:*—

"The mierobes of vaeine, like those of small-pox, are found exclusively in the form of mieroeoeci; and in no phase of their development do they assume any other aspeet than that of minute spherules.

"Neither in the small-pox pustule, nor in animal vaecine, nor in the viscera of persons who have died of small-pox, do we find tailed forms. We have then to do

* Klebs, "Archiv für Experim. Pathologie," x. 2, 3.

with pure micrococci, which in all the phases of their development pass into no other form."

The diameter of the vaccine-micrococcus is, according to Klebs' measurement, about 0·6 micromillimètre.

The micrococci of small-pox, and those of the pustules which are found in the calf after inoculation with human small-pox virus, differ somewhat from this diameter—that of the former being greater, that of the latter less. Perhaps the abundance or deficiency of nutritive material, as well as certain conditions of growth, influence these dimensions. These measurements of Klebs, it seems to us, may err, from the small number of cases from which they have been taken.

Then Klebs notes, as a characteristic more or less common to the microbes of vaccine as to those of small-pox, the disposition—so clear, according to him—to place themselves in groups of four, to such an extent as to deserve the appellation of *micrococcus quadrigeminus.**

3. How and when do the micrococci appear in the small-pox pustule or the vaccine-vesicle? How does their development take place, and what part do they play in relation to the changes which the anatomical elements undergo?

It is only in the vesicle of vaccine inoculation that

* At the meeting of the Société de Biologie de Paris, 29th July 1882, M. Straus showed several microscopical preparations of the vaccine-vesicle of the calf. There one observed numerous micrococci, coloured blue by gentian-violet, disposed in compact heaps or in linear series, following the lymphatic spaces. Their number and arrangement in the thickness of the Malpighian layer and the derma varied according to the period of evolution of the cow-pox vesicle. Towards the sixth or seventh day the whole thickness of the derma is invaded by the colonies of micrococci. See Appendix.

the fate of the microbe has hitherto been well followed. The work by Pincus,* published in 1882, gives in this matter the most accurate and the most interesting details.

Let us say, then, that the development, the growth of the vaccine-vesicle, does not differ at all, so to speak, from that of the small-pox pustule. It is always the mucous layer of Malpighi which is the seat of the first and principal organic changes. Even when the lancet has penetrated more deeply, carrying even into the meshes of the derma the fluid charged with its microbes, it is always in the epithelial layers that are developed the real phenomena of the vaccine inoculation. According to Pincus, the congestive reaction which succeeds immediately to the slight wound, corresponds exclusively to the mechanical lesion, seeing that it does not vary when inoculation is performed from the condition following simple puncture. These primary phenomena of reaction subside in turn, with complete cicatrization, within forty-eight hours.

As for the phenomena indicating the specific action of the virus, though less immediate, at least in their apparent effects, they are not long before they may be discovered. Within twenty-four hours of inoculation there may be observed in the "rete Malpighii" changes independent of the traumatic reaction, and which may be classed into three zones, of which the innermost, the true centre of inoculation, is the seat of active processes which Pincus believes to be of the nature of necrosis,

* "Untersuchungen über die Wirkungsweisse der Vaccination," vol. in 8vo, pp. 164, mit 4 lithog. Tafeln. Berlin: Hirschwald. 1882.

attributing it to the intensity of the microbiotic action. The nuclei are broken up, the cells become indistinct and develop into diffused masses, structureless and tinged with yellow (primary necrosis). The description by Pincus is similar to that given by Weigert of the small-pox eruption, and disposes of that furnished by French authors.

Whatever may be the nature of this preliminary change in the epidermic cells, it is proved that the micrococci multiply in the neighbourhood of these foci with extreme rapidity.

The second zone, less acutely affected by the virus, is denominated by Pincus the "zone of mild degeneration" (*zone de dégénérescence trouble*). The third, outside, is that of irritation: the cellular growth here seems to be very active.

As we have said, the slight injury (to the tissues) induces almost immediately a congestive reaction, with increase in the sanguineous and lymphatic circulation. This ordinary period of reaction is very short, and is generally followed on the second day by a marked diminution in the activity of the plasmic coincidents. The consequent rest lasts from twenty-four to forty-eight hours. This depression of the circulation is attributed by the author to the extreme local irritation; it is accompanied by a rapid multiplication of the microbes.

Between the third and fourth days the protoplasmic increase generally becomes very active, though we do not at present know the reason of this change. It is now that the development of the vesicle begins. Serum makes its way into the zone of inoculation and into that of dull degeneration; the outside zone increases in size, cellular multiplication is still active in it. At

length the epidermis is by degrees distended with leucocytes.

The common inflammatory phenomena of reaction now get mixed with the direct effects of the virus, and the parts played by each can no longer be distinguished. Some hours, generally a day, after the circulation has so actively recommenced, the constitutional feverishness begins. Is this febrile state due to the direct action of the microbes carried into the circulation, and to the effort made by the constitution to expel them? Or is it the result of a kind of impregnation of the organism by the products of the decomposition and change of the protoplasmic cells attacked by the microbe? We cannot tell. It seems proved, however, that direct injection into the conjunctiva of vaccine-microbes, does not give rise to acute febrile symptoms, and the experiments of M. Chauveau justify this mode of considering the subject; but the attempts made in this direction do not yet suffice to determine the question.

It is in the median portion of the Malpighian network that the micrococcus first develops; it is there also, as we have seen, that are found the first specific alterations. It seems that these small parasites cannot grow well in parts where there exists a very active plasmic current; and indeed Pincus notes this curious fact, that on the first day the multiplication of germs hardly goes on in the zone of inoculation, which is suffering from the effects of lively reaction and of a more rapid circulation, due to the lesion, but that already one can sometimes observe it further away, arising doubtless from some groups of cells carried by the nutrient lymph, then arrested outside the region immediately attacked.

As soon as the traumatic reaction is complete—that is

to say, on the second day—the micrococci undergo rapid increase, this time even in the zone of inoculation. Perhaps they alter all at once, the vitality of the epidermic cells, finding at length, in cells changed or even necrosed, an excellent nidus for their development. The hair-follicles must equally present conditions of existence favourable to the microbes; for, generally, entire colonies are found in them, placed, as we believe, in the preformed interstices of the sheaths and coverings of the hair.

When the reaction of the third or fourth day comes into play, development seems to stop, or, at any rate, to be greatly retarded. Without doubt, the newly-formed micrococci are in part carried away by the lymph, and proceed to infect the whole system.

An experiment performed by M. Chauveau seems to prove that this immigration towards the internal parts of the body is made at even an earlier period. Upon a portion of the skin in the region of the neck, in several horses, he made in a row five or six inoculations with a lancet. Twenty-four or forty-eight hours afterwards he completely excised the portion of skin which bore the inoculation-marks, and united with a suture the edges of the wound, which healed by "first intention." In this manner he prevented germ development upon the site of puncture; the local manifestation was necessarily absent. But this virus, previous to the excision of the tissue in which it had been deposited, had had time to enter the circulating current, where it had been bound to act as a general infectant, for at the end of fifteen or twenty days he was able to establish that a certain number of subjects thus prepared had developed at the "sites of election"—a vaccine exanthem whose characters were absolutely identical with those of natural vaccination.

On the fifth day, a period at which the crop of "lymph" may already have commenced, the micrococci are found in considerable numbers underneath the "horny layer;" often they seem by their growth to have penetrated the groups of cells, separating them like coins. At this period there exist also in the most superficial layers of the skin masses disposed in beds parallel to the surface, whilst in the deeper layers these masses are hardly ever found.

From this time to the eighth day the micrococci have gained considerably more ground; there are then present thick masses in the uppermost layer of all the necrosed parts, and groups push themselves forward into the depths of the derma. This takes place especially in the neighbourhood of the hair follicles, whose sheaths and peri-follicular lymphatic canals serve, so to speak, as guiding channels.

The micrococci of small-pox are generally met with in the depths of the derma at an earlier period than those of vaccine; often enough one can, at an early period, find entire colonies choking the lymphatic vessels and filling the capillary creeks of the papillæ.

The thing explains itself. In small-pox, a constitutional disease, the migration of the enemy is made from within outwards, and it has to traverse the papillæ in order to reach the selected layer, there to multiply. The contrary is the case with vaccinia, whose microbe travels from without inwards—that is to say, concentrically.

We have seen that, following the outward movement, from the third to the fourth day, a portion of the micrococci is taken up and distributed throughout the organism, while another portion remains on the spot and

continues to develop. We have only a few precise observations upon their final destiny.

Many of the micrococci seem to perish on the spot. One finds some whose volume has become much greater through absorption of water, a phenomenon precedent to, or even consequent on, the death of the micrococcus. Other micrococci retain, in the midst of dried cell masses and thickened juices, all their vitality, and keep it for a long time: the virulence of scabs detached from small-pox pustules or vaccine-vesicles—a virulence insisted on elsewhere—sufficiently proves this.

As for the micrococci absorbed and thrown into the general circulation, we know that those of inoculated variola collect in secondary foci when the system presents no obstacle to their action.

In fact, this inoculation brings about the local development of a small-pox pustule, followed on the fourth or fifth day by a general infection, to which the fever—the malaise—bears witness, and which most frequently is itself followed by a disseminated eruption of variable intensity, which appears from the eighth to the ninth day.

The fate of the micrococci taken from these new pustules, or from any varioloid eruption secondary to a general infection, or of those of the vaccine-vesicle, is at present unknown. It seems scarcely possible to doubt that these microbes perish in the body. But where, when, and by what mechanism? We can as yet on this subject offer scarcely more than theory, based on analogy with higher fungoid growths injected into the blood, whose fate has lately been inquired into, chiefly by Grawitz.

4. We have got thus far with the examination of this question: 'how can we explain scientifically the immunity secured by vaccination or inoculation?

Three hypotheses are proffered—(*a*) That of exhaustion, (*b*) that of antidotal power, (*c*) that of cellular alteration.

(*a*) The *first* presupposes that the morbid proeess induced by the virus consumes, destroys, or annihilates some material, otherwise unknown, whose existenee is necessary to the ultimate development of that virus. Originated by Klebs, it seems to have gained over M. Pasteur.

This theory, says M. Grawitz,* is inadmissible; *firstly*, because the body always rapidly replaces constituents that have been wasted; *secondly*, because mould-fungi do not determine decomposition in their surroundings, and leave intact whatever they do not assimilate; *thirdly*, "cultivations" show that the fungi need, in addition to oxygen, only a solution of albumen or peptone, which is not deficient in the blood.

(*b*) The *second* hypothesis (the antidotal theory, Klebs) is founded upon the fact that, in aleoholic fermentation, if the alcohol be in too great a proportion in the solution, it hinders the development of the mycoderm. This has reeeived additional support from the diseoveries of Baumann, Brieger, and Salkowski; they have demonstrated that, amongst the products of disintegration of albuminoid matters, are found bodies which possess antiseptic properties, like carbolic acid, or which are true antisepties (Wernich).† This theory has had, in so far as it concerns infeetion from splenic blood, a warm defender in M. Chauveau.

It is not less unlikely, says M. Grawitz again, since one does not see to what bodies the "mould" might give

* Virchow's Archiv. Bd. lxxxiv. p. 87.

† *Ibid.* Bd. lxxviii.

origin; and in any case, in supposing that they may be capable, like the "mucus racemosus," deprived of oxygen, of producing an antidote, the latter could only be in excessively small quantity, considering the infinitely small proportion of the mass of spores to that of the entire organism, and that this antidote must ultimately be carried outside the body by the excretions.

The *third* hypothesis is that of M. Grawitz himself. What happens, says he, when one injects spores into the blood? A struggle for existence between the latter and the tissue-cells. This struggle causes an increase in the vital energy of the latter. The immunity resulting from the primary inoculation would thus be explained by an increase in the power of resistance of our tissues, which, to be effectual, must surpass the vital energy of the parasite. Once induced, this vital resistance may last for months or years, transmitting itself by heredity from one generation of cells to the following.

Let us in our turn say to the author that this explanation, which involves the great natural laws of adaptation, &c., makes use of data which are interpreted arbitrarily, and which are infinitely removed from even the semblance of demonstration. None of these three theories then can be absolutely accepted. That of "exhaustion," however, does not seem unlikely at first sight. An experimental investigation, reported by Duclaux, plainly shows the delicacy of the germs, their need of nourishment, and their extreme sensitiveness. A "cultivation-fluid" contains a fifty-thousandth part of zinc; one or two generations of "aspergillus" will completely absorb this metal, and will render the existence of a new generation abortive or impossible.

"In such a fluid," says M. Duclaux, "a new 'sowing'

—I was going to call it a new inoculation—would be fruitless." "Let us add," continues he, "a sixteen-hundred-thousandth of nitrate of silver to the nourishing fluid, and vegetation abruptly ceases. It cannot even begin in a silver vessel, although chemistry may be almost powerless to demonstrate that a portion of the vessel is dissolved in the liquid; but the plant dying, proves it. Imagine the aspergillus a human parasite, able to live and to develop in the body, and invading every part of it; the quantity of nitrate of silver necessary to cause the disappearance of the parasite in a man weighing sixty kilogrammes would be forty milligrammes. If it multiplied only in the blood, five milligrammes would suffice to arrest the development of a plant so sensitive." It is true that other species might live where the aspergillus would die. Each ferment has its fluid, or its "site of election," and one comes to this conclusion, "*that all soils are not favourable to all cultivations, and that a favourable nidus is very quickly exhausted.*"

The theory of the ether, of its vibrations or its waves, is less justifiable. What scientific language can we use to make this evident? The theory of exhaustion may possibly, under the same title and with this object, help us to simplify the matter.

Whether it be vegetable or animal, the germ of vaccine or of small-pox needs, in order to exist and multiply, an appropriate nidus.

"One cannot," says M. Pasteur, "help thinking that the microbe finds, in the body of the animal in which it is about to seek a home, a favourable nidus, and that, in order to complete the cycle of its existence, it does not alter or decompose—which amounts to the same thing—

certain materials there present, whether it develops them for its own benefit, or whether it oxidizes them with the oxygen which it borrows from the blood."

Besides, all human beings, to speak only of them, do not appear to be, to an equal extent, a receptaele favourable to the life of the small-pox or vaccine germ : some are receptive, others refractory.

The germ sticks to the former ; in them it settles down and multiplies, because it there finds its "pabulum vitæ." This once exhausted, it dies of inanition ; from that moment immunity is acquired. If it come upon a subject refractory, either from birth or from previous exhaustion (of the pabulum), it is stranded at the outset.

Let us suppose the enemy *in situ :* it multiplies and nourishes itself until the subject is exhausted ; from this time the latter has no more to fear from its aggressions for an indefinite time ; but this time is not unlimited—there may arrive a moment when receptivity becomes re-established, and ean only be again destroyed by a new term of oecupation.

The germ, introduced anew, exhausts the subject once more, and makes him an unfit soil for new occupants.

For certain subjects a single eolony of inhabitants suffiees for their exhaustion ; for others two, three, perhaps ten, may be necessary.

Being unable to determine this beforehand, there is but one mode of procuring positive immunity, that of repeating inoculations at short intervals. In the matter of vaccine we call that *vaccination.*

It is needless to state that it is re-vaceination whieh should periodically re-establish immunity.

5. The vaeeine-vesicle, as we have said before, is infil-

trated with a serous fluid, which in man escapes as soon as we give it exit, carrying with it a certain number of the virus corpuscles.

For a long time it was believed that the vesicle, dried thus by the loss of its contained fluid, ceased to contain virus corpuscles; and in reality, when the first wave has escaped, if one allows new quantities of serum time to arrive, this serum entangles only fewer and fewer microbes, and the virulence of this latter fluid constantly becomes less.

Not that we wish to imply that the vesicle has lost in this manner all its active constituents. Far from that. We know to-day, and it is not to be doubted, that the framework remains crowded with micrococci, which fact excision of the vesicles in animals, impossible and unknown amongst children, allows us each day to place beyond the possibility of doubt.

Further on we shall see what use we have made of this information, in introducing methods of procedure which are of service in preserving animal lymph.

At any rate, if one opens, whether by incision or by simple puncture, a vaccine vesicle at the end of the seventh day, in the human species, so slightly as only to wound the external epidermis, there escapes from it a fluid which one is in the habit of calling "vaccine," similar to lymph-plasma, and holding in suspension divers foreign bodies.

These bodies are :—

1st. The Leucocytes, extremely rare at first, then becoming more and more abundant, until at length, in the purulent stage, they cover the whole field of the microscope. These leucocytes may be in a state of granular or granulo-fatty degeneration, &c.

2nd. Dead epithelial cells, various dead fragments often irregular in shape, arising from fission, &c.

3rd. Large multi-nuclear cells, developed perhaps by the confluence of several leucocytes, due also probably to the growth and multiplication of the nuclei of the epithelial cells, without corresponding division of the surrounding protoplasm.

4th. The micrococci described above. They exist nearly alone in the still clear fluid of the young vesicles. At this time they are isolated. Later on, they are found for the most part joined together in irregular colonies mixed up with the cellular elements in the fluid.

5th. Free irregular granulations, too irregular to allow of being termed micrococci.

6th. Various adventitious mixtures; red blood corpuscles, cells, and horny epidermic masses, mingled with the liquid; impurities of every sort that are found on the skin or are attached by accident to the vaccine-vesicle. It is clear that the fluid thus varies considerably according to the period of collecting it, the individual cutaneous organization, the precautions taken in gathering it, &c. It differs considerably amongst the various animals susceptible of vaccination.

6. Thus, as we have just said, the seat of virulence in the bright granulations (microbes, micrococci) is henceforth determined. It is again to M. Chauveau that is the due honour of having experimentally proved this important fact.

Vaccine-lymph from which the solid elements have been separated by the process of diffusion, ceases to be inoculable.

Below are the experiments undertaken by the

illustrious Lyons professor to establish his demonstration.*

"Upon a single subject (child, horse or cow), one inoculated the skin simultaneously by ordinary methods, at one spot with pure vaccine of good quality, at other spots with various dilutions of vaccine, formed of the same lymph with a gradually increasing proportion of water. One took care to make, in each series of inoculations, the same number of punctures, and to charge the lancet always with a similar quantity of fluid. These experiments have been frequently tried, in such a way as to test the activity of vaccine-lymph diluted to the greatest possible number of degrees. It is thus that I have come, in these last series, to inoculate vaccine-lymph diluted with 150 times its weight of water.

"As a rule, the first dilutions have shown themselves as active as pure vaccine. Vaccinations done with lymph diluted with two to fifteen times its weight of water, gave, as a rule, nearly as many successes as punctures. Arrived at the fiftieth dilution, on the contrary, the inoculations miscarried most frequently. I have however, in a single instance, obtained a vesicle from ten punctures made with vaccine diluted with 150 times its weight of water. As for inoculations performed with vaccine dilutions of a strength from one in fifteen to one in fifty, some aborted, others succeeded, but the number of aborted punctures was always greater with the more extreme dilutions. To these results it is necessary to add an important observation; in every case in which the inoculation succeeded, the eruption behaved itself in precisely the same way. The vesiculation followed a

* Nature du Vaccine. Determination Expérimentale des Eléments.

course and presented characters identical with the vesiculation produced by inoculation with pure vaccine. Failure or success, then, everything has been clear and complete in these experiments. Nothing mixed, intermediate or attenuated, has been shown in the results of these inoculations.

"Thus the result of these experiments has proved, upon all points, contrary to the presence of the virus in the plasma of the vaccine-lymph, and in complete conformity with the virulent activity of the solid elements floating in this lymph."

As we have just seen, greatly diluted vaccine-lymph can only very rarely be inoculated with the lancet. If this is really because the virus corpuscles, separated one from the other by dilution, can only exceptionally be carried on the point of the instrument, inoculation *en masse* of the diluted liquid should, on the other hand, certainly succeed, since we should thus place all the virus corpuscles contained in the lymph in contact with the organism. This, indeed, is what never fails to happen. By injecting into the circulating medium vaccine diluted, to it does not much matter what extent, we infect to a certainty the subject of the experiment. One of the prettiest cases of artificial horse-pox obtained by M. Chauveau was induced by intravenous injection of 8 milligrammes of vaccine-lymph diluted with 400 times its volume of water. This fluid inoculated with a lancet into several animals before the injection, had however not been able to produce in them a single vaccine-vesicle.

These data will be very useful in guiding us in the choice of operative measures in vaccination, and the manner of preserving vaccine, with which we shall have to occupy ourselves later on.

Concerning the Modes of Origin of Vaccine-Lymph.

7. For nearly a century, the question of knowing whether the vaccine we employ to preserve ourselves from small-pox, came in the first place from the cow or from the horse, has provided material for the most energetic discussions in the medical world.

When Jenner had determined that a certain number of persons who were occupied in taking care of and milking cows showed themselves insusceptible to the small-pox virus with which he inoculated them, he recognized that they owed this immunity to something they had previously contracted, doubtless through wounds in their hands—namely, a vesicular disease which they met with on the udders of these animals. Jenner was constrained to admit that the latter had themselves taken the disease from horses, with which they had directly or indirectly come into contact. "There is," says he, "an affection to which the horse is frequently liable on account of its domesticity. Farriers have called it 'the grease.' It is an inflammation and swelling of the heel; from it flows matter which possesses properties of a special kind, for it seems to be able to originate in the human body a disease which has so strong a resemblance to small-pox, that I consider it very probable it may be the source of the latter; but this matter must first have undergone a modification. In this milk-bearing country there are many cows, and the duty of milking them is entrusted without distinction to male or female servants. It may happen that one of the former, after

having dressed the heels of a horse afflicted with 'the grease' has not taken care to wash his hands, and may commence milking the cows, upon the nipples of which his fingers have deposited some particles of infectious matter which has remained adherent to them. When this is the case, a disease is communicated to the cows and to the maid-servants, which spreads throughout the farm to such an extent that the entire herd and all the servants feel the consequences."

This passage states explicitly that Jenner admitted as the origin of vaccine "a disease of the horse's heel which, transmitted to the cow by germs spilt upon the hands of men who have just dressed diseased horses, is transformed into cow-pox." And after having called this disease "the grease," he has given it later the name of "sore heels," an ulcerating disorder of the heels, which it will henceforth retain.

Jenner believed then that the source of cow-pox is a special morbid matter, developing itself upon the horse, and upon him alone. "I am well persuaded," writes he, "that this disease never develops upon cows, at any rate, unless they have been milked by some one who at the same time had charge of a horse afflicted with 'sore heels,' or unless this disease (the cow-pox) had been conveyed to a herd by a cow already infected with it, or by a servant who was already attacked by it." *

8. What then is "the grease?"

It is the disease termed by French veterinary surgeons

* Ed. Jenner, "An Inquiry into the Causes and Effects of the Variola Vaccinæ, a disease discovered in some of the Western Counties of England, particularly Gloucestershire, and known by the name of Cow-pox." London, 1798, in 4to, with plates.

Eaux Aux Jambes; by Germans, *Mauke;* by Italians, *Garpe.* In animals having undivided hoofs, it specially affects the skin at the upper part of the knee and the ham, and that of the lower portions of the limbs, chiefly around the coronet and fetlock, reaching almost to the hoofs; the disease is more frequent on the posterior than on the fore limbs.

"The grease" is described in all works on veterinary medicine. The disease generally has a mild course; sometimes it disappears from one foot to reappear on another; occasionally it disappears at the commencement of summer during dry seasons, to reappear in autumn when the atmosphere is moist.

It is not this that can be considered as giving origin to vaccine. The disease is much more like a diffuse phlegmonous inflammation. Isolated and deprived of the complication of vesicles filled with serum, which are sometimes added to it, it is this which in a work dated 1802, and which has long remained unnoticed, Loy ("Account of some Experiments on the Origin of the Cow-pox") called "local grease" to distinguish it from "constitutional grease." *

The "constitutional grease" of Loy is an eruptive vesico-pustular disease, whose characteristic eruption may have its seat upon the skin, or the nasal or buccal mucous membrane; exceptionally only on the conjunc-

* Le petit ouvrage de Loy, 29 pages in 8vo, bien qu'ayant été traduit en 1802, par De Cairo, dans la Bibliothèque Britannique, t. xxi. p. 377, n'a été connu en France qu'après que M. Bouvier, dans un discours tenu à l'Académie de Médecine de Paris, dans la séance du 2 Février 1861, et inspiré des conseils d'Auzias Turenne, l'eut exhumé et révélé. Il donne de la question une solution cherchée ensuite pendant plus de cinquante ans.

tiva. The eruption may appear over the whole surface, but its sites of election are the lower portion of the limbs and the head, where it often becomes confluent. The cutaneous eruption coincides, commonly enough, with that of the buccal mucous membrane, which in some exceptional cases shows itself only there. The nasal eruption, when it is present, is nearly always accompanied by a similar eruption around the nostrils and on the lips. A slight elevation of temperature, most frequently unperceived, precedes by three or four days the appearance of the eruptions.

The confluence of the eruption at the lower portion of the legs is so frequently accompanied by symptoms such as turgescence, inflammation, ulceration, and secretion, that confusion with the disease known as *eaux aux jambes* has become possible. Hence the idea, so long persisted in, of the vacciniferous property of "the grease."

9. The disease thus defined is that which M. Bouley has introduced into the nosological codes under the name of the *horse-pox*.* The eruption in *natural horse-pox* presents the following characters: At first when we pass our hand over the body of a horse, we perceive papules of the size of a lentil, and giving the sensation of hard bodies encased beneath the epidermis.

These papules, at the end of two or three days, seem to be about as large as peas, or even larger, through the serum which accumulates in them; they are more pro-

* Loy: Art. "Horse-pox," from the "Nouveau Dictionnaire pratique de Médecine, de Chirurgie et d'Hygiène Vétérinaires," par Bouley et Reynal. Paris. 1881.

jecting, with well-marked borders, and have an umbilication in the centre.

At the end of seven or eight days, the vesicle, arrived at complete maturity, is filled with serum; the partition of the apex of the vesicle is not always as clear in horse-pox as in vaccine, and often there are bullous or watery vesicles.

The pustules, which remain, so to speak, vesicles, open easily before the contents have become purulent, especially if they develop in a region in which the hairs are numerous; then the latter are bristling in small bundles, and get up again immediately if one seeks to replace them in their normal direction; on passing the hand along in such a region it is wetted by the serum which oozes down these hairs. In the vesicles which give way, as in those which dry with thickening of the contents, there forms a scab which adheres to the bases of the hairs, and joins together several of them. These bundles of hairs fall with the scabs at the end of a period more or less protracted (from the fifteenth to the twentieth day), leaving bare a small rounded surface, of a violet-red tint, sensitive to the touch, in which, however, the hairs grow again after some time. Often at a late period, when desquamation commences, one can ascertain the presence of itching. Upon the mucous surfaces, horse-pox shows itself in the form of blisters of the size of a pea—some circular, others oval—whose translucent rose colour shows out prominently from the red of the mucous membrane, which, generally inflamed, serves as a support to it. These vesicles are smooth on their surface, without any depression; under the finger they give a sensation of extreme tension, and the animal appears to suffer when one compresses them. When these pustules or blebs

follow their regular course, they beeome suceessively milky, then purulent; then they dry and give rise to a scab, which soon disappears, leaving in its plaee a slate coloration.

In the mouth, where the epithelium is easily rubbed off by fibrous foods, the eruption shows itself in the shape of sores, which seem to be made by a punch; the base is finely granular. Thcre is abundant salivary discharge, rendered frothy by the movement of the tongue. This saliva fills the buccal cavity, and escapes in flakes by the commissure of the lips. There is pretty frequently a mucous discharge by the nose.

Often thcre is confluence, as in place of vesicles there may be an ulcerated sore, more or less protected by scales; similar sores are not rare on the alæ of the nose and around the lips.

But the horse may present vaccino-varioloid vesicles having another origin. These may have been induced in him by the direct insertion, into the cutaneous submucosa, of vaccine-virus derived from the cow, man, or the horse, or perhaps by the absorption of this same virus injected into thc deep cellular tissues, the veins, or the lymphatics. In this case it is no longer natural but artifical *horse-pox* that we observe.

10. Whether it be with human vaccine, with cow-pox, or with horse-pox, that one has inoculated, the final manifcstations are the same.

The characters and the progress of *horse-pox* suceeeding the insertion of vaccine from thc ox have been described as follows by M. Chauveau:—"During the first five or six days following inoculation, one does not note anything special. From the fifth to the eighth day, the punetured spots become slightly papular. Until about the tenth

day the vesicles grow and become more glistening, taking the form of a cone much widened, with a breadth of from 10 to 20 millimètres at its base. During this period, these large conical papules are firm, tender to pressure, and present on their surface no elevation nor any other modification of the epidermis, which presents only a slight bluish tint in animals whose skin is somewhat pigmented. Then arrives a new phase, which may be termed the "period of secretion," and which commences from the ninth to the twelfth day; the epidermis slightly raised upon nearly the whole extent of the papule, allows numerous droplets of limpid lemon-coloured serum to exude; these droplets are soon matted into yellow transparent scabs, forming, over the whole surface of the vesicle, a kind of characteristic crystallization very different from the scab which succeeds vaccine-vesicles in man and in the bovine race. The secretion, which persists for several days, ceases from the thirteenth to the seventeenth day of inoculation. If then one raises the scab, one lays bare a surface, moist, granular, rose-coloured, causing no elevation above the surrounding skin. This surface is hollowed out by a pretty deep central cavity—a kind of umbilication in which is embedded, after the manner of a nail, a projection from the deep surface of the scab.

Such are the progress and characters that we generally observe in the vaccine eruption as induced in the horse.

11. Let us now, however, occupy ourselves with that pox which develops naturally in the cow, and which, by an abuse of language, which ill agrees with modern science, we still everywhere call *spontaneous cow-pox*.

The small-pox of the cow, or cow-pox, is often not

accompanied by any constitutional disturbance, by any fever, such as we find in most animals. However, these constitutional symptoms are not always absent, and one has especially noticed loss of appetite, disinclination for food, the continuance of rumination without the return to the mouth of the alimentary bolus, the diminution of the secretion of milk, which becomes more limpid and less thick than of old; it curdles more easily; the udder is sometimes congested and more tender; one finds then a dryness of the excreta, a lessening of the urinary secretion, more seldom an acceleration of the pulse, and general depression. After three or four days of this eruptive fever, which corresponds to the period of invasion of small-pox in man, one finds as a rule, on the breasts, but especially on the nipples, very exceptionally on the snout, the nostrils, the eyelids, and those parts of the skin where hair is seldom found (Hurtrel d'Arboral, Pilger), rose-coloured nodules, rounded elevations almost as large as a lentil, ordinarily already umbilicated. Towards the third or fourth day—about the seventh of the disease—the papules are changed into vesicles or pustules; that is to say, that under the epidermis, or rather in the latter, a serous, viscid, yellow fluid accumulates.

At this period these vesicles generally present, at their centre, a bluish coloration, and are yellow or orange, sometimes reddish, or even violet, at the circumference. People have occasionally attached extreme importance to this coloration of the vesicles, and have even sought to make of it an essential feature of the affection, the more so as Jenner had only spoken of the bluish discoloration; if the skin be merely of a fair hue, the shade will be reddish; if it be darker, it will be of a lead-grey. The

centre, then, of the vesicle is most frequently much depressed, umbilicated; the circumference is hard, swollen, and sensitive; and in animals having a clear skin there is a reddish areola surrounding the vesicle. On the following days the vesicles increase to acquire, from the eighth to the tenth day—or, according to Ceely, from the ninth to the eleventh—their greatest size; then is the most favourable time to collect the vaccine; only, it is necessary to be careful to make several incisions into each vesicle, in order to lay open the several compartments which form the swelling. At this time the vesicles have often the dimensions of a haricot-bean; upon the udder itself they are circular in form, whilst upon the nipples they are more elongated; the areola is more complete; in place of simple stains round the vesicle, the circle has a more uniform tint.

The contents of the vesicle soon become purulent. The surface of the pustule appears granular, lightly dotted, and one distinguishes, with the lens, a large number of little vesicles filled with transparent fluid.

Then comes the period of desiccation (the twelfth day), when, spreading from the centre, forms a crust, first yellow, then brown, which extends insensibly towards the circumference. This crust, thick and glittering, crystalline as has been stated, or rather scaly, is firmly united to the skin, and only separates after the fifteenth day, sometimes not until the third or fourth week, at any rate unless it be previously raised by an injury; it then leaves after it a scar more or less deep, which remains for a considerable time. In the bovine race only occasionally is there suppuration beneath the epidermis with ulceration of the chorion, and then the cicatrix is not indelible.

Rocel and Hering have remarked that the irruption of

the vesicles is not always made at the same time, since at the end of several days after the primary eruption they have often seen new ones, so that there may already be pustules in the stage of desquamation, while others are as yet showing themselves only in the form of papules; there are, in these cases, vesicles of all ages, ripe and unripe. The eruption may thus show itself by successive steps, and take from eight to ten or even fifteen days before it comes to an end. However, we believe we have noticed that once desquamation has commeneed, no more new vesicles spring up.

The confluence found in small-pox pustules is very rare in the cow—that is to say, that seldom are the pustules numerous or near enough to get mixed; there is not therefore much erysipelatous inflammation to replace the eruption.

The pustules are easily broken by any frietion—for example, by a rough litter, or by the hands of the milk-maid; the scabs thus produced stick less firmly to the skin and are easily raised, but then they form more quickly; suppuration tends to become more marked and ulcerating eracks form in their place.

We have not yet observed in cows a concomitant eruption upon the mucous surfaces, such as that which is only too frequent in human small-pox or "the rot" in sheep; there is, consequently, no nasal catarrh with swelling of the alæ nasi, no dyspnœa, no diffieulty in deglutition.

Cow-pox has always a regular course; it lasts barely eight days in what is called the false variety, but from twenty to twenty-eight in the true form. One can distinguish in it a period of incubation, which one can only determine in experimental or inoculated vaccinia; a

period of invasion, when we find more or less fever; a period of eruption, which is characterized by the appearance of vesicles, which are the essential part of the disease; then the period of desquamation, when the pustules are found replaced by scabs. This contagious disease once introduced into a cowhouse, soon spreads, especially among cows which the same individual milks. The disease spreads, little by little, to the other cows, but nearly always in a benign form, rather by a local infection—a species of inoculation—than by a constitutional infection. Once begun in a cowhouse, the cow-pox may remain there for months. We have, then, seen the disease spread to man, notably to people who have the duty of milking cows.

We believe it is determined that a first attack of cow-pox creates immunity in the animal. However, as the disease passes so often unperceived among our farmers, one cannot state this fact with certainty; too often, small-pox showing itself in the form of what is known as "false pox," is not taken into consideration.

The prognosis of vaccinia is, in nearly all cases, most favourable; the disease appears so benign that the men who watch the cows do not notice it; at any rate, they do not themselves develop any eruption on the hands.

12. The cow-pox may be inoculated into the cow by the insertion of horse-pox, of cow-pox natural or artificial, or of human vaccine. It is upon this property that depends the practice so developed during recent years of what is known as *animal vaccination.*

Compared with the effects of vaccination in the horse, those observed in the cow present some differences.

The vesicle in the horse is conical, in place of being shallow and umbilicated, as are those of the horse and

man; its umbilication only becomes obvious when the scab has fallen off.

As to the manner in which the secretion of the mature pustule acts, there exists between the pustule of the horse and that of the cow, and of man, a still more marked difference. In the horse, the secretion from the whole surface of the elevation is effective, even to the full extent of its base; whilst in bovine and human vaccine-vesicles the secretion is only active in the circle circumscribed by the areola. The subsequent scab corresponds to the secreting surface. It thus happens that in the horse it covers the whole pustule, while in the ox and the child it occupies only the centre.

With regard to the abundance of secreted fluids, the difference between the horse pustules and those of the ox is great. Whilst the first furnish a very considerable quantity of the virus-bearing fluid, with which one may fill a great number of tubes, the latter very rapidly becomes spoilt and dried. From a practical point of view, this difference in the fertility of the pustules in the two organisms should be taken into serious consideration, for if urgency should arise to necessitate vaccination of a great number of subjects at the same time, one would be certain to procure vaccine in greater abundance by inoculating the horse with it, than by trusting it to a member of the bovine species. And supposing that direct equine vaccination be not possible in any given locality, either from the nervousness of the operators or the subjects, the horse would supply the means of inoculating a great number of heifers and cows. (H. Bouley.)

Differences exist equally, from this point of view, between the vesicle (or pustule) of the cow and that of the

infant; for whilst in the latter the vaccine rises in hyaline droplets to the surface of the vesicle, when one comes to open the vesicle in the cow with the lancet or a needle, it is necessary to express the lymph by means of pretty firm pressure applied to the base of the little swellings, which in the practice of so-called *animal vaccination* renders special modes of procedure needful.

We have seen above (9) that in the horse the eruption induced by inoculation differs plainly enough from that which develops by constitutional infection. That is not the case with bovine subjects; whatever attention we may give to the one or the other, it is impossible to differentiate the pustule of so-called "spontaneous cow-pox" from that of cow-pox produced by inoculation, by means of a sub-epidermic puncture.

This similarity renders illusory any research which one might wish still to make into the causes of spontaneous cow-pox, with the object of renewing the stock; the first comer will be able, by means of inoculations well performed, with whatsoever vaccine, to give, on this point, change to the most expert. And the fraud is not wanting to produce that to which, by a false appreciation of the actual needs of practice, prizes are attached for the discoveries of cases called *spontaneous*.

Happily this research itself is only a relic of a past age. Wherever animal vaccination is practised, it is absolutely useless. If, indeed, constitutional cow-pox differs from inoculated cow-pox, as has been stated, in its excess of virulence, this excess would not be desirable in vaccinating human beings. Here, on the contrary, it would be necessary to neutralize it by causing the cow-pox to pass, in the first place, through the body of another of the bovine race.

Animal vaccination, as it is performed to-day in nearly every country, does nothing else.

Five times in fourteen years we have thus renewed our animal stock to satisfy the prejudiced. Never, no never, have we seen the new stock improve upon the old. And that explains how it is that bovine stocks, well cultivated, only deteriorate when they meet with unfavourable soils.

We must know how to manage these difficulties when they present themselves, by bringing forward reserves prudently managed.

From what precedes, it follows that the economy of the horse lends itself, more readily than that of the ox, to certain manifestations to which the latter may even remain a complete stranger. In the horse, vaccinia simulates more nearly human small-pox; like the latter, it may become constitutional after simple local inoculation, which does not occur in the ox.

13. Facts long known, and those recently discovered, may be brought together in the following propositions:—

1st. Under the influence of a special virulent contagion, small-pox may develop in man under the form of a constitutional malady, characterized by febrile symptoms and a specific general eruption.

2nd. Under the influence of a special virulent contagion, a disease having numerous points of resemblance to human small-pox, febrile symptoms and an eruption, may develop in various animals, but especially in the horse and the cow.

3rd. The virus taken from human (small-pox) pustules and inoculated in man, give rise in him to an identical eruption at the seat of insertion of the virus, and most

frequently to a general eruption, discrete and without much gravity, and with generally mild symptoms (Variolization, Inoculation).

4th. This same virus inoculated on the horse and the cow induces in them the production of small elevations, containing a matter which, retransferred to man, produces in him the same phenomena as those of variolization with human virus (Commission Lyonnaise).

5th. The virus borrowed from the disease of the horse, *horse-pox*, or from that of the cow, *cow-pox*, naturally evolved, and transmitted to man, gives origin in him to a characteristic eruption; that of the horse often induces a well-marked general condition, and sometimes pustules upon parts other than the sites of puncture. That of the cow is less active, and only exceptionally gives rise to a generalized eruption.

6th. The horse virus passing through the cow is then deprived of its superabundant activity, and perhaps, if then transmitted to a child, would not induce a constitutional affection.

7th. The *horse-pox* and the cow-pox may be developed by the direct carriage, voluntary or accidental of the virus, to regions denuded of epidermis or epithelium, whether by independent lesions (*eaux aux jambes*, excoriations of the teats by the milk-maids, &c.), or by the lancet of the operator. The symptoms produced in this manner remain local.

14. What then is this special contagion? We have already, in discussing small-pox, indicated that which conveys the disease to man. Is this contagion the same for man as for the horse or for the cow? Or, are there indeed different contagions for each of these species? This is the question of the unicity or the multiplicity of

the small-pox and of the vaccine-germ. The subject of most interesting discussions for more than sixty years, this question remains to-day almost untouched, demanding from modern science new elements (of elucidation) which will not be denied to it.

Let us be precise. Here we have small-pox, horse-pox, and cow-pox, developing naturally upon man, upon the horse, and upon the cow, and manifesting themselves by local and general symptoms scarcely differing in the different species except in degree. Have these diseases, which evidently belong (10) to the class of parasitic diseases, a common germ, or has each its special microbe?

Already, in 1864, M. Depaul had formulated the following proposition:—

"*There is no vaccine-virus. Vaccine is nothing but modified small-pox, attenuated in its passage through the system of the horse or of the cow.*"

These propositions, which not long ago we energetically controverted, demand henceforth to be treated with more respect.

Everybody to-day knows that M. Pasteur deprives the virus of chicken-cholera of its excess of energy by more and more prolonged exposure, in contact with air of its special microbe, developed in a cultivating medium, and thus transmits this disease in a benign form, capable always of rendering animals, which have undergone this form of the disease, henceforth invulnerable to its attacks.

He has established also that the microbe thus deprived of its excess of energy, may give origin to a stock of microbes in which the virulent energy remains circumscribed within the same limits to which it has been reduced, and that it is thus possible to found

"special breeds" (*des races speciales*), in which is preserved only the amount of virulence necessary to enable them to be utilized as vaccine, unable to re-exhibit their primary virulence, except under conditions yet to be determined.

We now know that M. Toussaint (of Toulouse) on the one hand, and M. Pasteur on the other, have arrived by different methods at similar results for the microbe of "charbon." In this case, it is by submitting defibrinated charbon-bearing blood to the action of a temperature of 55°, that M. Toussaint has succeeded in depriving the charbon bacterial fluid, to a certain extent, of its virulence.

M. Pasteur has gone further; and for this purpose it has sufficed to produce charbon fluid, deprived of germs by keeping them in contact with air at a temperature of 42° to 43°. It is possible to *fix* the attenuation thus obtained by cultivation in a warm fluid, in generations of bacteria yet to be born, and thus *to constitute of it a generic character.*

Can this lost excess of virulence be restored?

Yes, but under certain conditions.

And these are not visionary ideas; they are facts well and duly acquired for science, and passed for the future into the domain of practice. It will then be permitted to refer to them and if there is space to make by analogy, the application of them to other varieties.

15. Whether small-pox floats freely in the air, or whether it secretly breeds in germs, we suppose that it sheds itself indiscriminately over man, the horse, and the cow, and that it may be equally assimilated by all. With this hypothesis—very unlike that which creates a special microbe for horse-pox, which entails another for the cow-pox—all difficulties vanish at once.

The atmospheric virus, attacking man, gives him decided constitutional small-pox, if he have not been sheltered by a previous attack of the disease or by a preventive small-pox or vaccine inoculation, or by an original immunity of an unknown nature. The principal symptoms by which it shows itself are—a febrile state, and the development on various parts of the body of papulo-pustules, whose appearance is well known.

When the virus originating horse-pox—we do not admit that a virus can originate spontaneously in organisms any more than in the atmosphere—when this virus, we say, seizes upon the organism of the horse under identical conditions, we see the same febrile state suddenly induced, only less vigorously, and pustules produced scarcely differing in external aspect, but not differing in internal structure.

Further, if we inoculate the matter which they enclose, it creates immunity from small-pox or from vaccinia in the animal which takes it as well as it does in man.

And this is reciprocated in the germ collected from the latter.

And it is the same for the cow; with this difference only, that the reactions here are even less energetic than in the horse.

Well, then, let us admit for a moment that this virus is the only virus capable of communicating small-pox, and everything is at once explained by means of the theory of the attenuation of germs.

Meeting with the organism of the horse, the virus introduces itself and instals itself in a medium different to that with which it is familiar. It there undergoes a depreciation similar to that which charbon virus, culti-

vated in a special solution, with proportionate oxygenation and heating undergoes. For charbon, a temperature of 45° suffices to kill the bacterium in its solution; the growth, on the contrary, is rapid and abundant at 42° to 43°—that is to say, at a difference (of temperature) of 2° or 3°. Would it be astonishing that the thermal deviation, which is a degree less in man than the horse, should count for something in this depreciation of the virulent element? And from how many other points of view is not this difference in the nature of the two media emphasized?

Would there then be anything surprising in the fact that, under the control of such conditions, the small-pox virus should be deprived in the horse of a portion of its virulence? Of that portion, indeed, which rendered it capable of propagation to a distance, and of the minute dissemination capable of exciting that train of constitutional symptoms so marked in man? And, in fact, horse-pox is nothing else, symptomatically, than human-pox deprived of these two elements.

In the cow it is the same thing, with this difference, that the thermal deviation is two degrees at least. The average temperature in man is about 37·5°, 38·25° in the horse, and 39° in the bovine race (Zündel). And, curiously enough, as if it were necessary that facts should give us the reason by anticipation, we find that this thermal variation responds to a corresponding decrease of virulence.

We know, in fact, that the horse-pox is otherwise active as the cow-pox by this token, that it has been seen to produce a generalized eruption; and there is but one opinion on the danger of inoculating man with it, if it have not previously been made to pass through the

body of the ox, which, as everybody admits, deprives it of its excessive virulence, and reduces it to the state of inoffensive vaccine, completing thus the work commenced in its first journey.

The theory, which we have just established, of the single origin of small-pox and vaccinia, furnishes a reply to all objections. Take, one by one, all those which we have reproduced above (26), and you will see that not one holds good before the principal contention, which is so plausible—viz., the attenuation of the germ. All differences, as to mode of propagation, intensity of morbid manifestations, relative frequency of the two diseases, the epidemic or endemic state, adduced by Bousquet, and later by ourselves,* are explained by it without any difficulty.

Bousquet has asked to be informed of what nature, the change undergone by small-pox, traversing the ox or the horse would be. Does this transformation, says he, affect the chemical or the vital constitution of the virus? Or, does this constitution, remaining the same, limit itself to external manifestations? It is to cry out without cause when one is shown to be so exigent regarding a matter, so well established, that no one has ever even dreamt of asking its explanation, as to ask *how* the virus of so-called spontaneous horse-pox or cow-pox, too virulent to be inoculated in a child, needs only to pass through the body of a cow to become inoffensive. In the same manner as the philosopher who demonstrated movement in marching, let us show

* "La vaccine et la vaccine obligatoire à l'Académie Royale de Médecine de Belgique." Broch. in 8vo, p. 92. Bruxelles: Manceaux. 1881.

him the *fact* of the attenuation of viruses by artificial procedures, and let us beg him not to ask us anything more about it.

But supposing, says he again, that small-pox should change itself into vaccinia in its land of exile; scarcely has it returned to its own soil ere it would resume its symptoms, its aspect, and all its belongings. Well, this supposition again succumbs in presence of the experience already acquired, and which, by analogy, we apply so readily to the defence of our thesis:—

"The microbe deprived of its excess of energy may give origin to a stock of microbes, the activity of whose virulence remains within the same limits to which it has been reduced, and it is thus possible to establish special races, preserving only the degree of virulence necessary to enable them to be utilized as vaccine" (14).

This virulence, it is true, may reascend to its acme, but only on condition of being cultivated in suitable media, and *experience has proved that the human medium is not favourable to this reascension, for there is no example of it.*

The facts ascertained by the Lyons commission remain—facts, whose importance, without ceasing to be considerable, should not nevertheless be overrated. No one indeed will forget the enormous difference which there must be between the elaboration of germs through the whole extent of the economy, and that which takes place only in a small corner of space, as happens in the various procedures of inoculation by the elevation of an epidermic shred. And does not Nature already point out this difference to us, when she forces us to compare the intensity of the phenomena resulting from general absorption in natural small-pox, horse-pox, and cow-pox,

with the phenomena scarcely sketched in these same affections induced by use of the lancet?

No; before being able to conclude that one is forced to draw results only from inoculations there are yet some obstacles to overcome: there is, first, the intra-cellular, the intra-venous, the intra-lymphatic injection of human small-pox into the horse and into the cow; then variolar contamination through the atmosphere, of these same animals, by means of virulent matter inhaled in the form of finely divided powders. If from these injections or from this contamination small-pox results, the theory of unicity will still await its demonstration. But if vaccinia result—oh! then, the great dispute as to the origin of vaccine will be at once terminated; the cow and the horse will be in the future, only the laboratories where Nature herself undertakes to attenuate the germs of which she has need, for the work of prophylaxis conceived by the genius of Jenner.

I have made a great number of experiments in this direction with the illustrious co-operation of M. Hugues, the distinguished military veterinary-surgeon. They have all been performed on horses, and have all had negative results.*

That will not discourage us, we shall begin again. What, if the horses persist in not giving us the desired solution, that will be no reason, why we should believe that they have passed judgment contrary to our ideas. However precise may be the methods of modern experiment, we cannot argue from its silence when it is pleased

* "Nouvelles recherches sur les origines de la vaccine." Communication faite à l'Académie Royale de Médecine de Paris, le 10 Octobre 1883 (*Gaz. hebdom.* 13 8^{bre}, 1883.)

to be dumb; and concerning what in this species, experiment until now has been so slightly communicative, it does not follow that its sentence should be final.

However it may be, we are compelled for the present, and we are sorry for it, to consider the theory of unicity as simply a hypothesis. A respectable hypothesis however, for there is no other that gives so well, a key to the complex problem of which we have been seeking the solution.

Human Vaccination.

16. The inoculation of vaccine in the human race, whether it come from a child, or whether it be borrowed from a horse or a cow, is called vaccination. In the first case it is *human vaccination;* in the second, *animal vaccination.*

We practise the first by borrowing the vaccine matter from one subject for another belonging to the human species.

Whilst every individual, whatever his age, may with very few exceptions, be capable of receiving vaccine a first time, and of reproducing it, it is generally in children that we seek this reproduction for the purposes of vaccination. There are two reasons for this: the first, that the fine skin of young subjects lends itself more readily to the normal development of the vesicle; the second, that we know, pretty certainly, that we have to do with fresh subjects—that is to say, subjects submitted to a primary impregnation, which is not the case in individuals of greater age. In the latter, an attack of varioloid or a previous vaccination not having left any apparent traces, may mislead us.

Then, experience has shown that vaccination under these conditions gives origin only, most frequently, to an enfeebled virus, though the vesicles themselves apparently have a normal aspect and development.

When we speak then, further on, of *human vaccine*, it is always to the vaccine of a *child* that the expression will apply.

17. The mode of vaccinating varies, according as we make use of vaccine fluid drawn from the vesicle—vaccination from arm to arm—or of preserved vaccine.

1. VACCINATION FROM ARM TO ARM.—CHOICE OF VACCINIFER.

Experience has demonstrated that vaccine, to be of good quality, should come from vigorous and healthy children. One will choose then as vaccinifers those who have *passed* the age when certain diatheses, the syphilitic for example, may exist without any external manifestations—that is to say, at least three months. When possible, one will inform oneself of the health of the parents, and will reject every child born of a bad stock.

We shall reject, as vaccinifers, subjects suffering from skin diseases, diarrhœa, or acute maladies of whatever *nature*. It will, therefore, be necessary to examine them thoroughly. If the parents of the vaccinifers object, those of the children to be vaccinated are charmed.

Choice of Vesicles.—Even when observed in a most healthy child, the vaccine-vesicles may not all be of equal size. This variation makes little difference in the quality of the matter which they contain; a very small vesicle may give excellent vaccine.

As a rule, this is how true vaccine-vesicles show and develop themselves.

We have stated that so soon as the lancet of the vaccinator leaves the puncture-spot which it has just made, the latter is surrounded by a small rose-coloured circle, about a line in diameter, which foretells a successful result. This sign, as Bousquet well says,* is common to all punctures of whatever nature; it indicates nothing by preference for vaccine.

"The first, the second, and the third day," says Bousquet again,† "we find nothing, since there is no appearance of life in the punctures, no visible sign of deep and hidden action; so, for inexperienced eyes, the vaccinated subject is as if nothing had been done. This is the period of incubation common to all contagious diseases, but especially to the eruptive fevers.

"From the third to the fourth day—a little sooner in summer, a little later in winter—we find on each puncture a red point, more apparent to the touch than to the eye; indeed, the finger very easily distinguishes a slight swelling; it is only beginning, but it cannot stop there.

"The fifth day, counting from that of inoculation, or the second of the eruption, the elevation is more prominent, but there is as yet no special character sufficiently marked to enable us to recognize it for what it really is; so that if we had not been informed of its history, we should not suspect its nature.

"On the sixth day, it is impossible to be deceived. In place of developing at its apex as it had commenced, the elevation becomes wider, flatter, hollows slightly at the centre, and assumes a pale tint with a blue tinge,

* Bousquet, "Nouveau traité de la vaccine et des éruptions varioleuses." Paris: J. B. Baillière. 1848. † *Ibid.* p. 171.

which looks like the reflection of silver or mother-of-pearl. At the same time, the base is surrounded by a little red circle, as yet much circumscribed, but which each day extends more widely.

"The seventh and eighth day the same symptoms, a little more marked. The vesicle, then in its full vigour, is seen with all its distinguishing characters; one or two lines broad, of an azure white, surrounded by an areola more or less extensive, depressed at its centre, and surrounded by hardened edges, glistening, more elevated than the surrounding surface.

"On the ninth and tenth days, this show of symptoms acquires still more intensity; but the most remarkable change occurs in the areola, whose colour, more vivid, more scarlet, disappears with more difficulty on pressure being made with the finger, and extends for nine or ten lines in all directions. The subjacent parts are congested, and this congestion is proportionate to the intensity and the extent of the areola.

"After the eleventh day, the elevation begins to dry up; the silvery tint changes to brown, the areola diminishes, becomes pale and yellow; at length, about the twelfth or thirteenth day, the vesicle becomes dry, and is transformed into a hard, dark crust, which falls from the twentieth to the twenty-fifth day, leaving in its place an indelible cicatrix, so characteristic that, with a little experience, it is nearly always easy to recognize its origin.

"The vaccine-cicatrix is round, deep, figured, crossed by lines, and studded with a crowd of little black specks, which doubtless correspond to the cells with which the inside of the vesicle is furnished. It would be superfluous to add, that the more recent the cicatrix the more

is it mixed up with the tissues, but it is never completely effaced."

It is not always necessary that all true vaccine-vesicles should correspond to every detail of this description, even in the most healthy children.

We have seen the typical vesicle present itself on the seventh or eighth day, in the form of a white turban, surrounded by a red areola, causing an elevation bounded by hard and glistening margins. It is not always thus. Sometimes the areola is completely absent; sometimes even it is the elevation that is lacking; the tumour seems to be developed internally more than externally; the turban is replaced by a whitish mother-of-pearl zone, always surrounded then by an inflammatory areola, but making no elevation appreciable to the passage over it of the finger; the latter, on pressure, perceives only a sensation of induration, more or less deep.

At other times, again, the vesicle, in the child, presents the same characters as those which are most frequently found in the adult, whose skin is less delicate and less pliable. It is less flat, less umbilicated; it has neither the same regularity of form nor the same brilliance; the elevation is less clean, the edge less decided; the areola less vivid, less intense. In a word, it offers, in all its external characters, something undecided, more easy to feel than to describe, and which assimilates it, in some respects, to what is called "false vaccine."

In spite of these varieties of form, the vaccine enclosed in these vesicles, if the child be of a good stock and has received good lymph, may be used to inoculate others, with the same success as happens with that which comes from typical vesicles. If, however, the latter deserve the preference, it is because in them the lymph is more

abundant, situated more superficially, and exuding more readily. One will choose those, then, in vaccination from arm to arm, as well as for the collection of lymph in tubes, to which they lend themselves more readily than the others, which are more difficult to get at and more liable to an admixture of blood.

In order to obtain the vaccine from the vesicles of a child, it is of importance that we should seize its arm firmly and stretch the skin well. The vesicles then stand out in marked relief. This done, by means either of a lancet or a grooved needle held obliquely to the surface of the little swelling, we open the latter at different points, by punctures or superficial incisions.

We will take care that the child may not be able, by its movements, to anticipate the instrument; and on that account we will take for the hand that holds the latter, a *point d'appui* upon the arm (of the child) itself; and we will go to work with a light touch. If any blood appear, that vesicle must be discarded.

The punctures should be numerous, for by only making one there will come only a very little fluid, the cells which hold it not having any intercommunication. We must attack the vesicle by its surface and its edges; we then see the vaccine liquid rise in clear droplets; we receive it on the point of the lancet or in the hollow of the grooved needle, and we proceed to the operation itself.

18. *Insertion of the Vaccine.*—This has for sole object the placing of the vaccine in contact with the mucous layer of the skin (rete Malpighii). For that a simple puncture by means of a needle or a pin suffices.

The puncture, says Bousquet, is of Asiatic origin, as is also inoculation with small-pox. Abandoned to common

women, this operation was performed by them with three needles tied together. To this proeedure, as simple as it was easy, they added, aeeording to *Eastern* custom, the most superstitious praetices. Two strangers to our profession (Sutton *père et fils*) did away with this charlatanry, and aequired a reputation for themselves which rapidly eonducted them to fortune.

They say that the English profession became jealous of them, but it had the good sense to adopt the method, which, since then, has superseded all others without dispute.

The *puncture*, indeed, is a simple and certain proeess if one operates from arm to arm—that is to say, with *actual* vaeeine which has not been exposed to any influence capable of disintegrating its elements. Certain to be charged with some of the corpuseles in which resides the virulence, the point of the lancet or the grooved needle, passed under the epidermis, deposits them there to a certainty.

Some precautions, however, are necessary. The operator must *insist* that the arm of the infant about to be vaecinated shall be free from any clothing, in order that he may be able to hold it by its lower part with his whole hand; with four fingers on one side and the thumb on the other, he tightly stretches the skin; then, applying the point of the needle eharged with the vaceine fluid, obliquely and on a slope relatively to the handle—in order to guard against the liquid running off the point, as ink does from a pen when we hold the nib too perpendieularly—he makes a superfieial *puncture*.

If the needle or the lancet bear vaccine only on one side, it is this side that should faee the skin; the puncture made, before withdrawing the needle, we make a light movement of raising the point in sueh a way as to

produce a small epidermic funnel, and we shall thus be certain to ensure the arrival of the vaccine at its address. There is another method—that of applying the thumb over the point of the instrument, as if to wipe it against the lips of the wound, so some vaccinators recommend: an unfortunate precaution, for the finger carries away with it nearly the whole of the liquid in place of keeping it at its destination.

We have been considering vaccination performed on the arm; it is custom that pronounced for this site of election. One chooses the upper and outer part of the arm in preference to any other, for the simple reason that it is the most convenient spot. Some mothers ask us to vaccinate their children on the thigh, in order to avoid visible cicatrices on the arm. There is no good reason why we should refuse; it is necessary only to choose the superior-external part, less exposed to the contact of excrement than other parts of the limb.

It is customary to make three punctures on each arm; for boys one may arrange them triangularly: for girls, it is better to place them in a horizontal line, at a distance of a thumb's-breadth from each other. If one wishes to please the mothers and to spare subsequent reproaches, one will ask the mothers themselves to point out at what height they would like them placed. The horizontal arrangement allows of concealment of the cicatrices that will form, by the smallest possible sleeve.

One will avoid, as much as possible, drawing blood, not so much for fear that the vaccine will be carried away by it, as because relatives are frightened at it, and particularly because, in going deeply enough into the skin to make it bleed, we go beyond the layer in which the vaccine will develop (rete Malpighii). When the baby is

held, seated on the arm of its nurse, and the latter, like the surgeon, is placed in a good light, the operation ought to be performed without any appearance of blood, and without the child uttering a cry. What matters, shall we say? And we shall say wrongly. The more we take away anything formidable in the operation—pain and cries—the more shall we bring together believers and practitioners. It is necessary that, when the time for vaccination is come, no mother should be deterred by fear that we might make her little ones suffer.

The vaccination complete, we cover the arms, at the level of the punctures, with a pad of wadding, in order to maintain an equable temperature, and to preserve them from blows, from rubbings, and especially from scratchings which are termed ticklings, of which they very soon seem to be the seat.

There is something more in fact, in the act of vaccination, than the subcutaneous puncture; there is the introduction under the epidermis of a germinative principle which the instrument of the vaccinator places there. This principle, whether it be virus, microbe or ferment, immediately begins to proliferate, invades the adjoining interstitial paths, is sometimes even carried to some distance (supplementary vesicles), and induces in the tissues a nutritive change which borders on the phenomena previously described.

Between the moment of insertion of the vaccine and the fall of the crust with which the vesicle finishes, there is a period of from three to four weeks.

There are germs immediately at the point of insertion, those which have been left there and which soon multiply.

In about four or five days, sometimes sooner, the

swarm at the inoculated spot already makes a mound under the epidermis, and this heap grows until about the tenth day, when the swelling suppurates, then shrivels and dries.

The virulence of the contents of this little swelling is greater according as the swelling itself is younger. It is then by mistake that we have accused it, in its earlier stages, of producing only false vaccine; the contrary is the truth. About the seventh day, in the child, the vaccine-lymph is sufficiently abundant to supply what we need, without the active principles being below the desired standard, as they come forward normally to the point of the vaccinator's lancet. After the seventh day, serum is in excess, and a larger quantity of lymph is necessary to furnish a good vaccination.

It is then the seventh day, or rather the commencement of the eighth, that one chooses by preference for collecting the product of the vesicles—not, once more, because it is then most active, but because it is the most convenient period after inoculation at which it is possible to collect the lymph in sufficient quantity.

19. *Vaccination by Means of preserved Vaccine.*—Vaccine is the more active as it is employed at a period more nearly approaching that of its generation. Vaccination from arm to arm corresponds most nearly to this condition, and it would be desirable that the absence of a link might never interrupt the circle.

But this is not always possible, and the need of reserves to refresh the stocks, lost by want of direct human vaccinifers, has always been felt. Hence the search for the most appropriate methods of preserving, for a certain period, in vaccine removed from its vesicles, the greatest possible amount of activity.

The problem to be solved is more complex than appears at first sight. To preserve the microbe alive for the longest possible time, is one essential; to isolate elements whose introduction into the organism constitutes a danger, is another of no less importance.

When one makes a slit or a puncture in the skin of a child, and when one places in it some animal matter, one risks each time the question of life or death. To make the danger great, it suffices that the lymph be putrid at the moment of its introduction.

Doubtless, all children in whom we shall have inoculated putrid vaccine will not die, but all will have been threatened. And it is, probably, because we have thought too little of this eventuality that we have seen, and still so often see, inflammatory accidents complicating vaccination, especially when it is done with preserved lymph; these are phlegmonous pustules, erysipelas, abscesses. To the observer who has carefully watched vaccinations skilfully performed from arm to arm, and in other ways, it is beyond doubt that, in the latter, there are added supernumerary phenomena, due to the introduction into the artificial wounds of substances, playing nearly always the rôle of foreign bodies, often that of specific or septic principles.

In whatever way we take it, it is difficult to avoid this action of preserved lymph, but it is easy to discard, absolutely, the danger of septic action. It is to that that we must chiefly look. We shall see how seldom it is guarded against.

The best time for collecting human vaccine is that at which it is most active. This truth needs no demonstration; unfortunately this period is too near that of inoculation to admit of a sufficiently free collection; we must

wait until the vesicle has attained a certain development, until the vaccine flows spontaneously from punctures made on the surface of the vesicle. One cannot, in fact, in the child as we do in animal vesicles, express, by pinching, the vaccine shut up in the depths of the vesicle; one must content oneself with what exudes naturally. But the vaccine fluid scarcely exudes, in any quantity, until the end of the seventh day. Sooner than that there is not sufficient. Later on, there is too much—that is to say, that the active corpuscles are then drowned in too great a proportion of serum. Later still, it presents the other inconvenience of being mixed with *pus*.

We proceed to consider the ordinary methods of preserving human vaccine.

20. *Glass Plates.*—"These plates," says Bousquet, "are square; their sides are 6, 8 or 10 lines long; two of these are taken and placed alternately upon a freely opened vesicle in such a way that the moistened spots exactly correspond. We repeat this little manœuvre twice or three times, and when we think the quantity of vaccine retained by them is sufficient, we apply them one against the other, after having given the vaccine, however, time to become a little thick, so that it should not spread too much; it is a matter of two or three minutes. In France, it is customary to seal them, sometimes with white wax, sometimes with sealing-wax. In England, we do not take this trouble; we are content to bring the slips carefully together and to wrap them in tin-foil.

"I willingly adopt this process; it is more simple and equally as certain as others more complicated.

"If the plates be destined for a long journey—across the sea, for example—we place them in a little bottle with a large neck; this bottle is itself enclosed in a larger one,

and between the two is placed a freezing mixture of nitre and chloride of sodium.

"When we wish to make use of the vaccine spread and dried upon these plates, we must separate them. That is easily done with the point of a penknife; that managed, we begin by reducing the vaccine once more to the liquid state. Some advise that it should be exposed to the vapour of warm water; others, and Jenner among them, prefer cold water. We are of the same opinion as Jenner. Not that we should use freezing water: no extremes. The most convenient temperature at all times is that of an inhabited room.

"Although water does not sensibly change the properties of vaccine, it is better nevertheless to use it with discretion. For myself, I am content to plunge the point of the lancet into a glass of water; no more is necessary to moisten, to soften the thickened vaccine, and to render it fit to be inoculated. The remainder of the operation is as if performed from 'arm to arm.'"

Thus does Bousquet express himself. He could not foretell, it appeared, that many vaccinators, chiefly midwives (*sages-femmes*), whose interference in this matter one hardly tolerates, found it easier to use their warm breath—often perfumed with spirits or tobacco, or perhaps impure for other reasons—to replace the drop of pure water, of which we have spoken, and thus put the finishing touch to the inconveniences of a practice which should no longer exist.

The employment of glass plates, such as we have described, entails evidently a number of imperfections; one would have wished to point them all out.

In applying the plates with more or less delicacy, to the opened vesicles, in order to charge them, nothing is

easier than to entangle with the vaccine blood which may have become mixed with it, and which henceforth it will be impossible to recognize in it. In bringing the two plates together, we shut up in the enclosure the vaccine, granulations and serum, epithelial cells, often blood and air; in a word, all that is necessary to favour, at least to permit maceration—nay, putrefaction of the contents. In vain shall we have fastened, stopped up, sealed the edges of the plates—all that will not prevent the entrance or the action of air. And that is so true, that if after some days we separate the plates, and the interposed matter remain fluid or nearly so, which seldom happens, there arises a mouldy smell, scarcely a doubtful sign of the commencement of putrefaction. But if, on the other hand, we find it dried, we may well ask what we have gained by allowing desiccation to act slowly in a macerated product already more or less altered, in preference to making use of immediate free desiccation under the influence of a moderate heat and of rapid evaporation of the liquid elements, as is done in the case of ivory points, of which we shall shortly speak. Let us add to all that the complicated mode of preparation, of sealing, of the package of glass plates, if we wish to send them by post, and we shall find that nothing is wanting in the recapitulation of their imperfections.

One word more on this subject: M. Fonssagrives* has recently remarked "that vaccination practised with vaccine collected from a well-chosen vaccinifer, is a hundred times better than vaccination from plates, which, devoid

* *Gazette hebdomadaire*, 4 Nov. 1867, p. 695.

of a well-known and well-established scientific origin, ought to be placed on one side as dangerous and suspicious."

In spite of that, the traditional "plate" has still its partisans. Much good may it do them. Only let us beg them to eliminate from their routine practice that which is its principal danger: by adding to their little pool of vaccine a droplet of glyccrinc, which they must mix well with it, they will preserve it from putrefaction, and, the glyccrine being a stable body, they will find it fluid, or at least soft, after a very long while.

21. *Ivory Points.*—These constitute, in every respect, a useful mode of gathering, sending, and prescrving vaccine. These are little ivory plates, cut square at one end, pointed at the other, generally 6 millimètres wide by 36 long. The pointed end is thinned and pared on both sides, very sharp at its tip, so that in case of need it may itself serve for the *act* of vaccination. This practice is intrinsically good, since it entirely obviates the inconvcniences of thc possible contamination of instruments used for various purposes; ivory instruments, arc always inconvenient, however, as they do not admit of making clean incisions.

We dip the end of these points, for a length of 4 or 5 millimètres, into the liquid of the opened vaccine-vesicles; then we dry them rapidly, either in the sun or before a bright fire, not placing them in a temperature of more than from 30° to 40° Centigrade, so as not to spoil the vaccine in the fluid which bathcs them. It thus escapes all maceration, in the same way as preserves of roots dricd upon wicker grates, which defy the ravages of time. If the point be not intended for carly use, we smear the part covered by vaccine with a layer of mucilage of gum

arabic, acting as a varnish, to preserve it from the action of the air and its impurities.

Thus prepared, dry vaccine keeps for a very long time. For expedition, we fix the point through a label carrying instructions as to the mode of using it, we slip it into an envelope, and throw it into the post. There is nothing more simple.

Mr. Darke, of London, has recently contrived a little instrument, which he has patented in England and in America, and which is only a large toilet-needle with a glass head, with these differences, that the point is lance-shaped and the glass head is flat. It is upon this plane surface that the vaccine is placed, and where we dry it as is done with the ivory points. We make the scratches with the point, we place on these the vaccine, then we throw away the instrument, in order that for perfect safety it may be used only for a single patient.

In order to use either the ivory point or the Darke pin-point, we soak it in lukewarm water to soften the vaccine, then we rub the latter upon the scarifications. We then collect the whole (of the liquid) upon these, and leave it to dry.

22. *Glass Tubes.*—From 9 to 10 centimètres long, the glass tubes generally employed are capillary and enlarged at the centre. This arrangement combines the advantage of sufficient capacity with a fineness of the ends favourable to capillary action, and capable of being easily melted in the operation of sealing at a lamp. When commerce delivers them to us the two extremities are closed, in order that impurities and particles of dust may not come to obliterate the lumen. At the time of using, we break the two ends; one of them is placed opposite a droplet of vaccine from a vesicle which we have just

opened; the liquid runs in, especially if we incline the tube in such a way as to favour capillary action by adding to it that of gravity. The tube filled, we close it by holding the ends in the flame of a candle or spirit-lamp.

Tubes with a central enlargement have, over strictly cylindrical capillary tubes, only the advantage of being, on account of the fineness of their narrowed ends, more easily closed by heat. Cylindrical capillary tubes have always thicker walls, necessitating prolonged exposure of the glass to the flame, which is prejudicial to the life of the vaccine-germs.

"When we vaccinate," says Bousquet, "we break off the two ends of the tube, we adjust to one of them a glass tube or a straw, and blow gently on to a glass plate, on which the vaccine spreads, and from which we take it with the lancet in order to inoculate. It is easier to empty the tube upon the arm itself, on which we have just made scarifications to receive the contents. We thus lose less, and the whole of the vaccine arrives at its destination."

M. Fiard has invented a little tube 5 centimètres long and half a millimètre in diameter, open at one end and terminated by a small bulb at the other. This is how it is used:—We begin by rarefying the air contained in the bulb, with the fingers or in the mouth. That done, we take it by the stem between the thumb and forefinger, and we point it by the other end at the surface of the vesicle. At this moment, a condensation of the rarefied air of the bulb happens through the difference in temperature of the outside air, and the vaccine is drawn into the tube in greater or less quantity—that matters little; we must not think of filling it. The manner of sealing

is the same as for ordinary capillary tubes, except that there is only one end to close—that away from the bulb. The mode of emptying the tube is still more simple: break the point and heat the bulb, you will soon see the vaccine move and escape from its prison by reason solely of dilatation of the air. The sensitiveness of the instrument depends only on the size of the bulb and the smallness of the tube. All that reminds one of the thermoscope or the differential thermometer (Bousquet).

These tubes seemed forgotten, when M. J. Bineau * reintroduced them, believing he had invented them. "I freely confess," he writes to us, "that I believed the idea my own. I have since learnt that M. Pasteur employs no other tubes for the preservation of his viruses."

What is the value of tubes as a means of preserving vaccine? Let us hear what Bousquet says:—

"After having made use of the plates," says he, "the Central Committee adopted the tubes, and I doubt not that the authority of its example has contributed greatly to bring them into favour. The vaccine may, indeed, be preserved for a long time in them—ten, twelve, fifteen months, or more; but to say of a thing that it may be, is not to say that it always or often happens.

"Scarcely had the Academy taken up vaccination than I was struck with the small success of its supplies of vaccine to the country. To what did that point? We could not attribute it to the unskilfulness of those charged with the preparation of these supplies; the Academy had taken the trouble to retain those attached to the old Committee. There was no difference, then, in this respect.

"However, the Sub-Committee especially entrusted

* *Le Lyon Medical*, 18 Septembre 1881.

with the care of this precious store ordered an inquiry. It nominated M. Burdin, one of its members, who desired my co-operation. We vaccinated together, and for purposes of comparison, an equal number of children, some from arm to arm, others with vaccine preserved in tubes. The difference in the two modes was apparent in the result; the second produced about half as many vesicles as the first, although the vaccine in the tubes had not been taken a month.

"Following up this scale of degeneration, we find that vaccine deteriorates rapidly enough in the tubes; and if there were not exceptions in everything, it would be easy to state a period after which it loses all its properties.

"I do not know what happens in the capillary tubes, but I have very often observed that when one keeps them a certain time, the vaccine disappears little by little; then one is greatly astonished, at the end of five or six months, to find them nearly empty. My first idea was that they were badly sealed, though that was not apparent to the eye. I have adapted a glass pipe; I have blown, and the vaccine has not moved.

"What becomes of it, if it does not pass out? Can we admit that it evaporates, and that the product of evaporation remains as 'gas' within the tube? There is no sign of it. I conclude from this fact, and from others, that vaccine in tubes undergoes changes which can only be fatal to its properties."

We, as well as Bousquet, have observed these changes, and perhaps observed them more carefully than he. As for that, we have collected the vaccine from many vesicles in a number of children into large-sized tubes capable of holding at least as much as twenty ordinary-sized tubes. Then, this is what we have observed: although the

tubes were full of the clearest vaccine, hermetically sealed in a spirit-flame, at the end of two or three days we have found the liquid already clouded, become milky, with little white clots forming, large or small, the smaller ones sticking to the walls of the tube, the larger sometimes occluding its whole lumen. If we now empty the tube, we find that the vaccine has acquired an odour more or less distinctly mouldy, which becomes putrid if we wait a little longer. A parting is formed; the solid elements are grouped about it in such a way that, under the microscope, we find them brought together in a mass, in place of being distributed.

If we use this vaccine with a lancet and operate by punctures, we risk more and more the chance of charging (the lancet) only with serum, and of making fruitless vaccinations. And that already explains, without its being necessary to fall back upon maceration or putrefaction to explain them, the numerous failures referred to by Bousquet: *nearly half more than by arm-to-arm vaccination, although the vaccine had not been preserved more than a month!* To diminish this proportion, we may advise that the tube be rolled rapidly between the fingers at the moment of using, in order to cleanse its walls, and that then the whole be turned out upon the scarifications made for the purpose. We shall thus have a chance of succeeding better, for the whole of the contents will have penetrated and been useful. But there remains this uncomfortable *mouldy smell*, to which we cannot show ourselves indifferent.

A great Belgian chemist (M. Melsens) wishing to procure perfect closure (of the tubes) without having to fear the action of too high a temperature (sealing by means of the spirit-lamp), or the formation of empyreumatic

products (sealing with wax), has devised the following process: *—

"We make use of capillary tubes with sufficiently thick walls; we collect the vaccine in the ordinary way, and when a convenient quantity has been introduced, we cause it, by means of a few shakes, to run into the tube in such a way as to leave a little column of air at the orifice. Then we plunge this end into a drop of pure water placed upon a suitable plate, and we incline the tube to make the vaccine run. The water enters by means of the slope given to the tube and by means of capillary action; but the vaccine remains separated from this column of water by the little cylinder of air interposed.

"We cease adding water when the vaccine has been forced to within a few millimètres of the dry end, and which we must not allow it to reach; then we close the orifice by introducing it into the flame of a little spirit-lamp or the edge of the flame of an ordinary candle, which answers perfectly. The closure obtained by fusion of the glass leaves no doubt as to the perfect and unalterable sealing; the slight conducting power of glass prevents the heat from coagulating or altering the vaccine placed at this end of the tube.

"We then perform the same operation at the other end; the water has rinsed this part of the tube and carried with it the trace of vaccine deposited upon the walls; at the first application of heat, a little explosion due to the watery vapour which forms, drives away the latter in part, and we then obtain complete sealing, without producing any trace of empyreumatic products.

* *Journal de la Société Royale des Sciences médicales et naturelles de Bruxelles*, t. liii. p. 525, Déc. 1871.

"If natural liquid vaccine can be preserved, when it has come into actual contact with air, we are certain, in operating as has just been described, to have done away with all possible causes of change, arising from a closure often, if not always, incomplete; the proceeding described, with the exception of the use of an elevated temperature, places the vaccine under the conditions of *conserves d'appert;* the conditions of preservation are even better in this instance, since we avoid the use of stoppers, of wax, of soldering and of metals, glass being unalterable.

"It may be asked, with respect to the preservation of virulence, whether tubes thus prepared do not, to a certain extent, resemble bodies, dead from infectious diseases (typhus, &c.), shut up in leaden coffins and hermetically sealed by metallic soldering. We know that, in disturbing graves, accidents happening to the coffin have produced in the workmen the same disease that caused the death of the corpse enclosed. One is compelled, reasoning by analogy and induction, to say that the *virulence* or the special *infection* which had attacked the living, had been preserved, with its special properties, in this corpse, which diffuses it and attacks afresh with the disease to which it has succumbed, the living beings exposed to its emanations."

M. Melsens having received, on November 25, 1871, four small tubes enclosing human vaccine, decanted it, added to it about ten times its volume of water, and introduced this mixture into five new tubes, which were sealed as usual in the spirit-flame. On June 24, 1874—that is to say, three years and a half afterwards—this vaccine was still active; of six punctures which had been made, there was one which gave origin to a perfectly characteristic vesicle.

The manner of operating—by the puncture—and the great proportion of the diluting water, explain sufficiently why only one out of six insertions was successful. The fact of the long preservation of the germ remains nevertheless indisputable.

This fact is interesting to record, and justifies us in the care we must take in preserving, in order to enable vaccine to retain its virulence for any considerable time. The procedure of M. Melsens should be remembered; it may sometimes be useful.

For ordinary use, so many precautions are unnecessary. Here is the best course to follow, in order to give to vaccine in tubes all that it is possible to give and to preserve it with certainty from putrefaction—it is that which Dr. Edward Müller, Director of the Vaccine Establishment at Berlin, has long recommended: "We place in a watch-glass a mixture of purified glycerine and distilled water, in equal parts. In this liquid we receive the lymph obtained from the vesicles. The distilled water is used in order to make the mixture more fluid, and to allow of its introduction into the small tubes. The lymph does not dissolve easily in the glycerine, and it is well, before using it, to facilitate the mixture by means of a pin."

M. Müller estimates that we may thus, from the vesicles of a child, collect a quantity of lymph sufficient to half fill a watch-glass, in such proportions that the lymph constitutes about a fifth part of the vaccinating solution thus prepared. M. Müller has been able, as far as that goes, to dilute the lymph with ten times its weight of glycerine and to inoculate it with success.

We never advise anything of that sort; confidence in the proportion of successes can only result from the

quantity of pure vaccine in the mixture. We engage to do this with equal parts, and no further. The pool thus obtained being very fluid, the liquid rapidly runs into the tube which we present to it. We close it by the cold method, following the plan of M. Chambon, by thrusting the two extremities of the tubes into little cylinders, prepared by melting together three parts of paraffin and one of suet. We at once see a short column of this mixture rise in the tube. The closure is satisfactory; to make it a little more solid and to finish up, we plunge the two ends, *secundum artem*, into an ethereal solution of caoutchouc, which is termed, commercially, *capsulage artificiel.*

If we wish to prepare tubes with a view to prolonged preservation, we have recourse to the following procedure, which is but that of M. Melsens' improved: We oppose the tube first to a drop of pure olive or sweet almond oil, which we allow to rise until a column about half a centimètre high is formed, then to the vaccine, which drives the former to within a centimètre of the other end; then once again to the droplet of oil, which sends the first to the end of the tube. We seal in the lamp. The vaccine is thus enclosed between two columns of oil, which preserve it both from evaporation and from contact with the air, even though the sealing by the lamp be imperfect, which too often is the case.

22. *Inoculation with preserved Vaccine.*—M. Bousquet, in the book which for more than thirty years has been the gospel of the vaccinator, lays down, so far as concerns the mode of vaccinating, various aphorisms, from amongst which we select the following:

"1st. Procure good vaccine, it is the important point;

'then puncture as you please, we shall not be uneasy as to the result.

"2nd. If the lancet be well charged, it is needless to charge it afresh for each new puncture, each fresh scratch. The *quantity* of vaccine adds nothing to the result; whether it be little or much, what matters?

"3rd. If the vaccine used be in a clot or dried, we must moisten it and reduce it to the fluid state with some drops of fresh water, then insert it, taking care to leave the lancet *in situ* for some seconds.

"4th. I maintain both incision and puncture to be good, and almost equally so."

These precepts are indeed only applicable to arm-to-arm vaccination, to vaccination performed with vaccine, which, for facility of expression, we shall call "living." When we use *preserved* lymph, we must hasten to forget them, or rather to practise the converse of them. Thus:

1. Take a good preparation; satisfy yourself, if it be fluid, that it exhales no smell; then use it in such a way that it shall be placed in the epidermis, in contact with large absorbing surfaces. To that end, apply it over numerous scarifications, and be sure, by using moderate friction, that it penetrates well. *Guard against being content with punctures*, or you will reap only disappointments.

2. The *quantity* of vaccine introduced considerably influences the result. If only a little penetrates, it is probable that the vaccination may fail.

3. If the vaccine be dried (vaccine on points), we must soften it by steeping the point in tepid water, and make abrasions or scarifications with it; if blood appear, allow it to dry, then rub the flat surface (of the point)

over the scarifications, for a sufficiently long time, only ceasing friction when the ivory has lost all its vaccine. If blood gets mixed, let everything be collected over the scratches and allowed to dry.

4. *We maintain that puncture should be avoided.* Scarifications should be used, to the exclusion of every other mode of introduction.

These precepts are dictated by this undeniable fact, that in preserved lymph the active principles have suffered, that some have perished, and that in order to ensure the arrival of a sufficient quantity at its destination, we must open wide the door. Add to this, that in preserved vaccine, whether it be dry or liquid, the virus granulations are grouped, instead of being uniformly distributed throughout the mass, there is the probability of finding the lancet-point charged with little or none.

What shall we say after that of those inventions, which tend exclusively, in view of preparing for threatening deficiency of human lymph, to distribute it as scantily as possible, spreading it by means of a brush over the points of a multitude of needles, and allowing it to dry there, to make it serve according to need for vaccinations or re-vaccinations? A deplorable practice, the fruit of those precepts of Bousquet which we have recited above, and which make no distinction between "living" and preserved vaccine.

We do not know how to repeat it sufficiently: vaccination by means of preserved lymph can only compare with that from arm-to-arm, by supplementing quality with quantity. What if it were called to serve as the basis of a public service of vaccinations or re-vaccinations, and the dilatory ones wished to keep to their old routine of practising punctures, there would be many fruitless

vaccinations, a remediable error it is true, in a certain measure, in the case of vaccinations, but one which we could not avoid with too much care, in *re*-vaccinations, where security must be as absolute as it is possible to make it.

We must then ABSOLUTELY introduce preserved vaccine LARGELY into the scarifications. It is sufficient, as a rule, to make slight scratches with a pin or a needle. But, however simple the operation may be, there are still many practitioners of the old stamp, who, fanatics on *puncture*, still find a weapon to attack the more recent and more correct practice of scarifications; they still find it (scarification) difficult of execution, and, in fact, make *incisions*, sometimes too little, sometimes too big; here too superficial, there too deep.

To help these unskilful ones, M. Ninć, a Belgian military surgeon, has invented a very ingenious instrument. We shall speak of it when we treat of animal vaccination, for the practice of which it has been manufactured.

CONCERNING ANIMAL VACCINATION.

CHAPTER I.

DEFINITION, OBJECT, AND REASONS FOR THE PRACTICE OF ANIMAL VACCINATION.

1. We have given the name of *animal vaccination* to that which is practised with the aid of vaccine cultivated in members of the bovine race. It is a conventional term; the vaccine from a child is as much *animal* as that from a heifer.

Animal vaccination seems to be a recent invention. Who could state that positively? We have it from the lips of an old practitioner that in his youth he had seen his father—the village doctor—inoculate the nipples of a cow with human vaccine that had been preserved through the winter, in order to renew the stock of fresh vaccine at the recommencement of each vaccinating season. Others must have done the same.

We know also that, during many years, Doctor Vy (of Elbeuf) performed animal vaccination on a large scale, by inoculating calves with human vaccine, and that the same method has been made use of for a long period

in many parts of Germany, and especially in Bavaria. That has been called *retro-vaccination.*

The meaning which we must nowadays give to the words "animal vaccination" is more restricted. *Animal vaccine is the product of natural horse-pox or cow-pox which has been cultivated on heifers, and has never quitted that soil.* Thus defined, animal vaccine is of recent date. History informs us that it was practised in 1800 by Duquenelle at Rheims, and by Valentin at Nancy; that it was introduced into Naples in 1810 by Galbiati, and that from this period it developed there, to be taken up later by Négri, his pupil. A tale is still told how formerly the Queen of England sent to the latter, from Scotland, a cow attacked with spontaneous cow-pox, in order that he might use it to renew his vaccine; but nobody says that Galbiati ever did anything but retro-vaccination.

Should we reproach him for that? We shall be careful not to do so. Our own theory of the unicity of vaccines forbids it. We know that natural horse-pox loses a portion of its virulence by its transference to the heifer; in a similar way the natural vaccine of the heifer may be deprived of some of its activity in passing to the child. But nothing hinders us from believing that, carried once again to the cow, human vaccine might develop in such manner as to exhibit again all the qualities of cow-pox, in the same way as the latter may rise again to the dignity of horse-pox when re-transferred to the horse. It is a question of soil. We have therefore no reason to object to the practice of retro-vaccination, remembering always that a cultivation carefully performed, may have assured to the products of emigration the restoration of their original activity.

Let that be as it may, to avoid any doubtful interpretation of a question still much discussed, we shall in this chapter allude to animal vaccination only in the restricted sense which we have previously attached to these words.

Thus comprised, animal vaccination is, in fact, a new method; it was, indeed, only at the close of the year 1864, after Professor Palasciano, of Naples, had attracted to it the attention of the *savants* met at the Medical Congress of Lyons, that the question was brought under serious consideration. In 1865, Dr. Lanoix, of Paris, after having, during several weeks spent at Naples, followed M. Négri step by step in his practice, brought from Naples a heifer which had been vaccinated there by the latter. On the way home, at Lyons, he vaccinated a heifer and several children from the product of his vaccinifer. Then, on his arrival at Paris, he had the great kindness to send to us, at Brussels, a heifer vaccinated by himself, which was the origin of the Vaccine Institute which we founded in 1865. This passed, in 1868, into the hands of the Government, under the name of *The State Vaccine Institute*, and we undertook the direction of it. In 1882, again, it became an adjunct of the State Veterinary College. We, for our part, maintained it as a private establishment, and it still exists under the name of *The Vaccine Institute of Belgium*.

From the institution at Paris, and from our own, arose numerous branches, which blossomed into the various establishments for animal vaccination that are now at work in most of the large towns in Europe and America.

In all civilized countries, vaccination is accepted and put in practice as the most certain, and indeed the only, preventive of small-pox. In vain, from time to time, do sceptics raise doubts as to its efficacy; their opposition

serves only to render more active and more convincing a truth henceforth settled. As a rule, the objections made to vaccination are of two kinds: on the one hand, it would tend to shut up in the organism diseased principles which an attack of small-pox might expel: it might thus give origin to other diseases just as severe, whose development it would be desirable to avoid. On the other hand—and this is directed especially to the public—it would present, in addition, the great danger of exposing patients vaccinated to being, in the act of vaccination, impregnated with constitutional diseases, with which those furnishing the matter for inoculation might be affected.

Justice has long ago been done to the first of these objections; as for the second, we are bound to receive it as established, at least in so far as concerns syphilis, and we cannot decline to give satisfaction to those who, notwithstanding that vaccination is rendered obligatory by law, experience objections whose legitimacy could not be equitably disputed. The occurrence of contagion, indeed, although considerably exaggerated by the mistrust of the public, nevertheless shows itself from time to time in practice.

We have more than once been reproached for having quoted this in advocating our subject. The reproach is undeserved. We have stated that it was an element of the question to which we were bound to give great attention, and we repeat it. Wherefore should we say otherwise? Is not the confession in all our consciences, and ought we, in refusing to explain it, to believe ourselves in safety, like the ostrich when it has hidden its head under its wing?

We shall do nothing of the sort. Everything that has

thrown light on the subject is adduced to interest our readers. It is, then, to the accomplishment of a real duty that we devote the following paragraphs.*

2. *Vaccino-syphilis.*—This question gave origin, in 1864, to an exhaustive discussion amongst the members of the Academy of Medicine of Paris. It was an attempt to discover whether vaccine from a syphilitic subject might with impunity be inoculated on a healthy person. Thus placed, the question appeared as though it should promptly have been decided in the negative. There was, in fact, but one opinion as to the indispensable necessity of surrounding the practice of vaccination with every possible guarantee; but it was asked, at the same time, whether no danger to the traditional inviolability of the practice invented by Jenner would not attend a loud-sounding inquiry. Is syphilis at our gates? cried they; does it threaten to invade our domestic hearths under cover of vaccine? would it not be imprudent to make a fuss concerning this beneficent institution, and thus to compromise the lively faith which society and the medical world have in it?

The Academy would not allow itself to be affected by these considerations, and did not wish that the facts which crowded in from all parts should be covered up, thinking justly that to know a danger is the surest method of avoiding it. Besides, it had a past to efface. Had it not, in 1830, said to all the vaccinators of France: "Vaccinate without fear, vaccinate always, for the vaccine virus taken from subjects afflicted with complaints

* Warlomont, Lecture on Vaccino-syphilis and Animal Vaccination, delivered at the Royal Academy of Medicine of Belgium, June 30, 1866 (*Bull. de l'Acad. de Méd.*, 1866, t. ix. No. 6).

susceptible of being communicated by contagion, such as syphilis, does not convey any such germs, in any case, and gives origin only to vaccinia." Could it consent that such a dogma, upon which a whole generation of doctors had leaned for thirty years, should continue to be proclaimed without appeal, when a succession of facts, upon whose significance doubt could no longer be placed, came constantly to contradict and condemn it?

The discussion then opened bravely: not a theory, not an observation was neglected. All the facts stated were so scrupulously examined, some amongst them were found to be so far above any possibility of doubt, that, at the end of the debate, every one agreed to accept vaccino-syphilis as an incontestable fact, rare it is true, but something that it was out of the question to dispute. It was then that we heard the illustrious ex-surgeon of the Hôpital du Midi make this declaration, which will emphasize his long and glorious career: "At first I denied the possibility of the transmission of syphilis by vaccination; but facts repeating themselves, and becoming more and more confirmatory, I admitted with reserve, and even with repugnance, this mode of transmission. To-day I do not hesitate to state it as a fact."

This declaration by M. Ricord was of great scientific importance. It was known that proofs and evidence would be necessary to affect his almost immovable convictions. It was known that the inquiry, pursued under his eyes, could not have left in the shade any circumstance of interest, and for the future the question might appear decided.

It has not been so. "Let," cried the objectors, "an exact description of a single case of syphilis produced by vaccine be given; let it be demonstrated in this case that

it is indeed syphilis that has been observed, and that the vaccine only has had any chance of producing it, and I will own myself convinced." In presence of this demand, there remained only to recommence the debate, and that is what we are about to do.

Many years passed in the apparent security created by the instruction evolved, in 1830, from the Council of the Academy of Medicine in Paris. I say "apparent," for, at the same time that the innocuousness of vaccine was proclaimed on all sides, there was not a mother who did not claim for her child, a doctor for his patient, the condition that the lymph should be taken from a pure, immaculate source. One then held in constant suspicion, as before, all lymph collected from any source which did not present its two or three degrees of constitutional purity. This traditional, instinctive mistrust must have had its results, for, whilst vaccinating with their wonted skill, many doctors contemplated the possible dangers of vaccination, and accumulated evidences to bear them out. Hence the reaction of 1860, still young as we see, but young only in years; for as the result of a collection of facts carefully accumulated, it should not have long to wait for development and importance. In fact, as until then one had been careful to hide even from oneself—so great was the influence of what had been decided—the accidents to which vaccination might be liable, so, now that the idol was broken, one was impelled to publish the facts acquired by observation, timidly at first, but gaining courage under the impetus of the active champions who threw themselves into the controversy.

I will not here unfold the long catalogue of cases of vaccino-syphilis from this time forward reported to the scientific world. Those who might be desirous of learning

all their details will find a description of them in a monograph published in 1860, by M. Viennois,* and in a work by M. Depaul, dated 1865.† More than 300 cases of vaccino-syphilis are there described. All have been examined with care, and if any among them may be excluded for want of being sufficiently exact, the greater part evidently deserve to be accepted.

It is not to be said on that account that I expect to see them admitted without reserve. If vaccination be sometimes followed by the symptoms of syphilis, I may be told that it is because it has been practised upon the children of syphilized subjects, who, to hide their troubles, waited for the general reactionary movement which vaccinia entails, and in virtue of which the cutaneous functions become active, to bring about the exhibition of the signs of a diathesis until then latent or incompletely developed. We ourselves can cite in this connection with much reason, the case of a child vaccinated by M. Friedinger, of Vienna, and quoted by M. Viennois,‡ which, very soon after a "regular" vaccination, had developed a confluent bulbous syphilide, although at the time of vaccination it had all the appearances of the most blooming health.

In order that this objection should have weight, it would be necessary to admit that all subjects who have shown symptoms of syphilis after vaccination should

* Viennois, De la transmission de la Syphilis par la Vaccination (*Archives générales de Médecine*, 1860, t. i. p. 640; t. ii. pp. 32, 297).

† Depaul, La Syphilis Vaccinale, devant l'Académie impériale de Médecine de Paris" (*Séances de Décembre* 1864, Février et Mars 1865).

‡ *Loc. cit.* t. i. p. 647.

already before its performance have been affected with the syphilitic diathesis. Let us see, then, what happened in one of the cases whose history has made most stir—that of Professor Gaspard Cerioli:

"A little girl of three months (a foundling) was vaccinated with vaccine taken from a healthy child who remained healthy. Normal vesicles developed and were used to inoculate forty-six children. Six of these latter had normal vesicles, from which a hundred other children were inoculated, who subsequently showed no sign of syphilis. Amongst nearly all the others were observed, at the spots where the punctures had been made, ulcerations covered with permanent crusts, or indurated ulcers. These accidents supervened from the period of the fall of the vaccine scabs. Later, there appeared ulcerations of the mouth and of the sexual parts, scabbed eruptions upon the scalp, copper-coloured spots, attacks of ophthalmia, all symptoms which were communicated to the nurses and mothers of these children."

Well! if in this instance we reject the vaccinal origin of the symptoms accused, we must admit that forty out of the forty-six children referred to were affected with syphilis previous to vaccination, a proportion truly inadmissible. As a matter of fact, what do we find in Paris? asks M. Devergie. In the service of the Institute of Nurses, in the course of a year, 2,200 children are entrusted to 2,200 nurses, and among this number we can scarcely establish the presence of two cases of congenital syphilis in a year. These children are soon sent to establishments in the country, where other nine or ten cases of hereditary syphilis develop; altogether twelve or thirteen, say fifteen, cases amongst 2,200 children. See then at what proportion we arrive, and

compare this number with forty children syphilized out of forty-six, in the evidence of Gaspard Cerioli.*

But there is another argument powerful in a different way. In nearly all the cases of vaccino-syphilis that have been collected, the initial lesion has been an *indurated chancre*, located at the point of puncture, and soon followed by the whole of what has been termed the syphilitic constellation. That is so well established, that in the description of it which he has given us, M. Rodet says in accurate terms: the vaccino-syphilitic chancre has the characters of the *indurated* chancre, accompanied by the characteristic indolent adenitis.† Then, if it be true, as one of the primary aphorisms of the Ecole du Midi states, that *the pox never repeats itself*—that is to say, that an individual afflicted with constitutional syphilis acquired by heredity or by an indurated chancre, is not in a state to contract another indurated chancre, in the same manner as a subject recently vaccinated can no longer produce a vaccine vesicle; if that be true, I say, it is clear that individuals affected with vaccino-syphilis represented by a syphilitic induration on the arm, were not afflicted with syphilis at the moment of vaccination, since in that case they would only have been able to develop manifestations foreign to the characteristic induration. All these subjects were then, from that fact alone, free from any suspicion of previous constitutional syphilis, which the act of vaccination would only have served to render active.

The excessive rarity of cases of constitutional syphilis,

* Discussion sur la syphilis vaccinale à l'Académie de Médecine de Paris (*Séance*, du 14 Février 1865).

† *Gazette Médicale de Lyon*, 1866, p. 160.

in comparison with the prodigious number of vaccinations performed during twenty-four years, is another argument which should not be lost sight of. But we must not forget that under the influence of fixed ideas relatively to the non-inoculability of secondary syphilitic accidents, not a doctor was disposed to believe his eyes did he find himself in presence even of the most pronounced case of vaccino-syphilis. And if it happened by chance that a mother accused the vaccine of a fault of the kind, were we not all too ready to treat, as idle stories, complaints perhaps too true? How many cases have thus been denied an examination to which they had a right? We know, besides, that syphilis progresses more slowly than vaccinia, and that, very frequently, the vaccinated ones are already far away when the specific accidents show themselves; they thus escape rigorous and impartial observation. Many physicians will tell you, that in their long career they have annually vaccinated hundreds of children, without having ever had to note accidents that could be imputed to the operation. But how often have they seen these children again, in the country especially or in the dispensaries, after having inoculated them? The greater part escape all observation, and if, later, syphilitic symptoms are manifest in any among them, doctors believe themselves authorized to place these without question to the account of an anterior diathesis, too happy in thus avoiding a well-marked responsibility, to even question her whom the doubt might have affected.

One word more on this matter. On November 29, 1864, M. Depaul, Director of Vaccination at the Academy of Medicine of Paris, in his scheme of the report to be presented to his Excellency the Minister of

Agriculture, Commerce and Public Works, said: "The Academy can refer to its experience, which is one of the most extensive; it procures the benefits of vaccination for 2,000 to 3,000 individuals each year, and to this day it has not had to show a single case of vaccino-syphilis developed amongst them." An unfortunate speech, for scarce had nine months gone by, than the contrary chance knocked in its turn at the gates of the vaccine department of the Academy.

*Obs.**—M. A. X., twenty-seven years old, had never had any venereal troubles other than two severe attacks of gonorrhœa, while preparing to go to Frankfort to see his father who was suffering from small-pox, came on August 19, 1865, to the Academy of Medicine, where he was re-vaccinated in the absence of M. Depaul, by another person, who made six punctures, three on each arm with a needle charged with vaccine taken from a child of about six months, pale and of meagre aspect. The same day, several children and several soldiers were vaccinated with lymph from the same vaccinifer. M. X. does not know whether the vesicles of the vaccinifer contained blood or not. Four vesicles resulted from the six punctures made, two on each arm, at the site of the two higher punctures. They were examined at Frankfort by a doctor, who thought them of good character. The scabs fell on September 12.

On his return to Paris, M. X. observes, about September 20 (a month after the vaccination), the presence of two new elevations, at the level of the two punctures which till then had remained unproductive;

* Millard, Physician to the Hôpital Saint Antoine (*Union Médicale*, Decembre 1865, No. 147, p. 466).

these soon changed into dry, brown scabs. A month later, about October 20, he begins to experience very violent pains in his head, especially marked at night, "*as soon as he places his head on the pillow*," which prevent sleep, and also some vague pains in the chest. Two or three days afterwards, some slight red spots, unaccompanied by itching, show themselves on the anterior aspect of the chest and abdomen. The pains in the head become so severe, that he goes on November 6 to consult Dr. Millard for what he calls his rheumatism in the head, and for the general *malaise* from which he is suffering. After a somewhat superficial examination, M. Millard was about to prescribe some anti-neuralgic treatment when M. X. happened to speak incidentally of his re-vaccination and of his two slowly developed vesicles, whose scabs, said he, had not yet fallen, seventy-eight days after the operation.

This was a ray of light for M. Millard; he at once caused his patient to undress, and discovered, at the upper part of each arm, a thick brown scab, below two recent cicatrices of normal vaccination. The scab on the right arm did not differ sensibly, in its size, its brown colour and its thickness, from legitimate vaccine scabs; but that on the left was much larger, of conoid shape, of dark greenish-black colour, very thick, and as though formed of several scaly-layers: it reminded one of the scabs of *rupia*. It was difficult to feel any indurated base underneath these scabs, but so soon as they had fallen, the induration had been plainly perceived. Further, in each axilla, were felt several swollen lymphatic glands, forming a veritable constellation. Then over the chest, on the arms, and especially on the lateral and posterior regions of the trunk, was a papulo-vesicular eruption sufficiently

spread, absolutely indolent, presenting all the characters of a syphilide. This had not attacked the upper limbs, he had not had any sore throat, and the fauces were healthy. A single gland, slightly swollen, was felt at the occipito-mastoid region. The headache had the syphilitic character, being worse at night, affecting chiefly the crown of the head, seeming to increase with pressure, and very much aggravated by the contact and heat of the pillow.

The genital organs, minutely examined, were healthy and bore no trace of cicatrix; he had no swelling of the glands in the groins, and further the patient, interrogated afresh with persistence, swore that he had never had a chancre.

"After this examination, I shall remain convinced," says M. Millard, "that M. X. was attacked with vaccino-syphilis; that he had been inoculated with this syphilis on August 19; that the scabs which still remained on the arms nearly eighty days after inoculation covered two ulcerations of a chancrous nature; that the glandular enlargements in the axillæ were the consequence of them, and must have been present some time; that further, the almost simultaneous appearance of the headache and the cutaneous eruption on about October 22, that is to say at the end of two months, followed out the most customary mode of evolution of the syphilitic diathesis.

"Much disturbed and almost embarrassed by this discovery, understanding the gravity of such a fact, since it was at the Academy of Medicine that the inoculation had taken place, scarcely six months after a celebrated discussion, in which it had often been repeated, with a kind of satisfaction, that during the more than sixty

years that they had vaccinated at the Academy thousands of children each year, they had never observed vaccino-syphilis, I determined that this should be observed by a physician whose testimony could not be called into question, and a consultation being just then possible, I myself took M. X. to my excellent master and friend, Doctor Hardy.

"After having examined and interrogated the patient, the able physician of the St. Louis Hospital did not hesitate to form the same diagnosis, and to declare that the syphilis had been inoculated in the month of August by the vaccine punctures. We ordered a mixed treatment, consisting of pills of the green iodide of mercury, and a solution of iodide of potassium. This last was meant to relieve the patient as soon as possible of his painful headache. I also advised my patient at once to inform his uncle, Dr. S——. The latter took his nephew on the same evening of November 6th to see M. Ricord. The eminent syphilographer, who, we reminded him, had in the previous January, with much vigour, controverted at the Academy M. Depaul's report, and who had contested several observations mentioned in this report, did not hesitate to yield to the evidence and to recognize that in M. X. *revaccination had been the starting-point of syphilis.* He in consequence prescribed a treatment. I have seen the patient several times since; the scab on the right arm fell on November 9, and has been succeeded by a rounded reddish cicatrix, glistening but little and *slightly indurated.* On November 14th or 15th, the crust on the left arm separated in its turn and gave place to a large, circular cicatrix, with a base *plainly indurated,* and similar to that of a chancre. The headache has rapidly

disappeared under the influence of iodide of potassium taken concurrently with the pills of green iodide; the eruption on the trunk, after having increased a little, already commences to fade, but it is still very characteristic. The patient continues to follow M. Ricord's prescriptions regularly, and to hope that he may soon be cured. On December 1st he left Paris to take up his duties at Constantinople.

"M. Depaul, since being informed of this unfortunate case, has commenced an inquiry into the vaccinations performed at the Academy on the 19th of August last. Nine children had been vaccinated at the same time as M. X., and with vaccine from the same child. Six of them have been found to be evidently attacked with syphilis; they are on the road to recovery, thanks to specific treatment which M. Depaul himself supervises; two are dead, without our having been able to trace exactly either the cause of death or whether they showed any syphilitic developments; the ninth child has not been found.*

"As for the vaccinifer, he had been sent to nurse into the Department of the Basses-Pyrénées, and he appeared to have succumbed, with all the signs of syphilis. The mayor and doctor of the neighbourhood should be able to send exact details concerning this child.

"There remain the soldiers vaccinated similarly on the 19th of August, with the same infectious vaccine, and of whom there is yet no trace. We do not know exactly how many there were of them; several of them have left Paris, either to change garrison, or to go on foreign

* This one has been found since the date of publication of this observation. He was also syphilized.

service, or to return to their homes. Nevertheless, we hope to find them. A professor from Val-de-Grâce has been good enough to undertake this difficult and delicate inquiry, and will send the results to M. Depaul, who proposes later on to publish a detailed account of these regrettable occurrences."

There is the account as it was brought forward last December by Dr. Millard. Since then we have been able to procure the following further particulars:—Of the nine children vaccinated on the same day, and with the same vaccine, M. Depaul has traced, not six, but seven. About ten weeks had passed when he saw them; all bore indubitable traces of a general syphilitic infection, all so much alike that to describe one described them all. Here is one of the observations: *—

Emile C——, aged eleven months, vaccinated on August 19, by three punctures on each arm. Four vaccine vesicles developed normally, and at the end of three weeks had passed through their regular course. Fifteen days later—that is to say, five to six weeks after inoculation—there appeared, in two cicatrices on the right arm, and in one on the left arm, a thick elevation, which ulcerated and attained the size of a five-centime piece. On November 13, the general condition was deplorable; the cachectic state well marked, ulcers on the arms *indurated*, roseola over the whole surface of the skin, the axillary glands large and indolent, a group of glands in the cervical region, mucous tubercles behind the left ear as well as round the anus.

This child and all the others have been subjected to a

* A communication written by M. Depaul.

mercurial course, and under its influence all the conditions have improved and have ultimately disappeared.

There remain the soldiers, whose destinies had remained a mystery, and of whom three have recently been found in turn at the hospital of Val-de-Grâce, each one having indurated chancres on the arms at the points of inoculation of the vaccine.

To complete this interesting series of observations, I have begged M. Ricord to be good enough to inform me if he had really passed, on M. Millard's patient, the opinion which the editor of the *Union Médicale* attributed to him. Here is his reply, dated the 5th of this month:

"Sir and Honoured Colleague,—I was indeed asked to examine M. Millard's patient alluded to in the *Union Médicale*, and I have been able to establish in this patient, as in several others, a case of transmission of syphilis by means of vaccination. At present I have only been able to see the results of this mode of contagion, I have not yet had the opportunity of verifying its sources. In all the cases, vaccino-syphilis, whatever be the conditions and the mechanism of communication, appears to be now an established fact.—Believe me, &c.,

(Signed) "Philippe Ricord.

"Paris, June 5th, 1866."

In presence of documents so precise, of facts so firmly established, we ask if doubt be still admissible? Indeed, nothing is deficient in the preceding observation. Was the disease observed really syphilis? It was so considered, first by M. Millard, then by MM. Hardy, Depaul and Ricord. Could syphilis have been already existent in the vaccinated before they were submitted to inoculation? Impossible; for all of them developed *indurated* chancres

following in the train of vaccination, and *the pox does not repeat itself*. Had syphilis been able to gain entrance by any other mode? Let us note that, among the eleven subjects, there were seven children, and that in each of them, as in the four adults, the initial lesion was located in the deltoid region.

There is, however, one omission—it has not been possible to produce the vaccinifer to whom all the mischief is imputed. He was dead when we wished to find him. The body of the delinquent, then, is wanting, and it might be admissible to make use of that fact. How, it may be said, can we admit a complete impeachment when the first link of the chain is absent? Well, there is no need of this first link, for the vaccinifer might be perfectly healthy, without any portion of M. Millard's observation being found incorrect. We will explain. In multiple vaccinations by batches, if we may be allowed the expression, one occupies oneself exclusively with the interests of the vaccinated, not at all with those of the vaccinifer. We watch very attentively, when we watch at all, that the latter should not lose a single drop of blood, but we trouble ourselves but little to learn whether the lancet or the needle which has just produced a puncture may not convey something to the vesicle from which it is about to draw anew. Perhaps the danger is very slight for the vaccinifer himself, for it is doubtful whether the vaccine vesicle is suitable to active absorption; but it is not the same for those vaccinated in the succeeding series, who will thus be exposed to a suspicious inoculation with all its consequences. Thus, in the case of M. Millard, the first subject vaccinated (other than those noted) might have poisoned the vesicle, and have been the point of origin of the whole catastrophe. Mark that

we only give this explanation as subsidiary, for *the* vaccinifer of the Academy of Medicine appeared to have died with all the symptoms of syphilis, if one agrees with the reports furnished.

Perhaps, in spite of the precision of the facts which we have just brought forward, one may meet with some sceptical spirit resolved to dispute their correctness rather than their interpretation. This resistance to belief in phenomena which one has not had the opportunity of observing personally, and which are opposed to notions and creeds long indulged in, is too natural to be blamed; besides, in controverting as long as possible, does not one force one's opponents to formulate their theory more accurately, to support it with more exact observations? Far from arresting progress, scientific scepticism consolidates it in a manner similar to the opposition to which governments have to submit, and which, far from turning them backwards, on the contrary, forces them to progress. In this matter opposition, foreseen and announced, has compelled us to be more detailed in our explanation: truth will lose nothing by it.

Scientific denial, however, has its limit. It is necessarily the duty of the wise man always to recognize facts well established, although that may be hurtful to his conceit. It is this that the illustrious ex-surgeon to the Hôpital du Midi has had the courage to do, after loyally perceiving that certain laws which he had taken for granted and long maintained, had recently been overturned by observation. We know that some have termed this abandonment of ancient creeds desertion, and, for their sakes, we are sorry for it. Scientific principles are not articles of faith, which one could not abandon without ceasing to be orthodox. Of human origin, they are like

all things human, liable to error. To wish to make of them a banner to which one should swear fidelity, is simply to put fetters on progress. Let us say to those who would range themselves under such a banner: *Save us from going so far.*

If we limit ourselves to the recital of this single fact, it is because all the others—those of the Rivalta, of the Palatinate, and so many more—have been the objects of more or less serious discussion. This case of M. Millard, on the contrary, has not been disputed; that is why we have believed it would be a useful thing to give a complete and detailed account of it.

We believe that the possibility of the propagation of syphilis by the act of vaccination must now be considered an established fact. There remains to discover in what manner this propagation is brought about. Several hypotheses are before us.

In the first (we shall not revert to the accidental contamination of which we have previously spoken) we suppose that a child affected with the pox is submitted to the classic vaccine punctures. May it not happen, M. Melchoir Roberts has said,* that at the moment of development of the vaccinal elevations, some superficial ecthymatous pustule, or rather a flat pustule with a pseudo-membrane on its surface, may come to be mixed up with the vaccine vesicle, to hide itself beside the latter or to take its place? In this instance, with the vaccine one might inoculate the secretion of the secondary eruption. This supposition is the more admissible as, in a young child affected with syphilis, the least irritation—a slight scratch—may determine the localization of the malady.

* *Union Médicale*, 1862, t. iv. p. 147.

M. Cullerier has proved recently, in a syphilitic child attacked with ecthyma, that any scratched portion of the skin, when dried up, became the seat of an ecthymatous pustule.

The second hypothesis is that which makes the blood play the active part in the development of syphilis by vaccination. For that, we must admit that the blood of a syphilitic inoculated on a healthy individual can communicate syphilis to the latter. Observations of accidental cases of this kind were not deficient, but there was wanting a direct experiment intended to throw light on the fact in such a way as no longer to permit of doubt.

This experiment has been performed; here it is:—

On February 6, 1862, in presence of all his pupils, Dr. Bargioni, free of all syphilitic taint, submits to an inoculation practised upon him by Dr. P. Pelligari, Clinical Professor of Venereal Diseases at the School of Medical Practice at Florence, by means of blood taken from the cephalic vein of a woman twenty-five years old, exhibiting all the symptoms of constitutional syphilis, and innocent of all previous treatment. All precautions are taken—new bandages, new lancet, new receiving vessel. Whilst the blood is flowing, some lint is impregnated with it, and applied to the superior external portion of Dr. Bargioni's left arm, after the epidermis has been raised and three transverse incisions been made.

On March 3, in the morning—that is to say, on the twenty-fifth day—M. Bargioni perceived, at the centre of the surface where the blood had been inoculated, a slight elevation which caused a little itching. Professor Pelligari affirms that this little round dark-red papule presents no induration at its base; no glandular enlarge-

ment. They cover it with a little dry lint, and protect it from rubbing by the aid of a piece of diachylon plaister.

On March 11, the papule has the circumference of a twenty-centime silver piece; it is covered by a light crust (squamous) of silvery colour, and very firmly adherent.

On the 12th and 13th the scab thickens, becomes more firmly fixed, cracks at the centre.

On the 14th, two glands as large as hazel-nuts, movable, indolent, appear in the axilla.

On the 19th, in passing the finger over the scab, we find a small quantity of purulent serum oozing to the surface, with pain on pressure.

On the 21st the scab separates, allowing one to perceive an ulcerated surface; slight induration at the base.

On the 22nd the scab falls, and one finds a chancre of funnel-shaped aspect, whose edges offer an elastic resistance which very well represents specific induration; these edges are swollen, adherent, oblique in relation to the floor of the chancre; but little secretion; but slight pain.

On the 26th the chancre is as large as a fifty-centime piece; infundibuliform; secretion increased; induration greater.

On April 4, the chancre still present; nocturnal headache; glandular enlargements in the posterior cervical region.

On the 12th rose-coloured spots over the whole body; glandular enlargements of the neck more marked.

On the 22nd the colour of the erythema is decidedly coppery. Lenticular papules are mixed with it. The primary chancre has projecting edges.

Mercurial treatment is commenced.

Nothing is deficient in this observation; neither the

merit of the master, nor the courage, nor the perseverance of the victim; the experiment is pushed as far as possible, and, the proof obtained, master and pupil proclaim the result aloud, bravely making sacrifice, upon the altar of science and of truth, of all considerations drawn from human respect. May this example not be entirely lost!

An experimental demonstration could not be more complete. In the train of ideas which the mention of this has suggested to us, one might raise objection to the extent of the contaminated surface which it had been necessary to impregnate with syphilitic blood in order to make it fructify. Perhaps some one will say that it has never happened after a simple inoculation. Vain evasion!

The fact of the inoculability of syphilitic blood being established, the danger of introducing syphilis with vaccine no longer needs demonstration. The danger is there; it is palpable and altogether inevitable; for if the blood is contagious, it is impossible that vaccine lymph, which rests on a surface impregnated with this blood, should not in its turn be to a certain extent saturated. It follows therefore, that no precaution can with certainty place a doctor beyond the risk of transmitting syphilis in vaccinating. Listen to what Ricord says on this matter:—

"The child from which we take the vaccine, may have every appearance of the most perfect health, and nevertheless have latent constitutional syphilis. It is the same with the relatives, with the legal relatives at least; for in syphilography the old adage of right may undergo some such variation as this: *is pater est quem morbus demonstrat.* There may be a concealed third party, and the parents that one sees are not always a

sufficient guarantee. After how long a period may one practice vaccination without risk? It is not possible to say. One may always expect to find the pox show itself during the first six months: it is the rule; not that it never shows itself immediately, but because in many cases five or six months elapse before its first manifestations. There is therefore no security earlier than the sixth month.*

Although this last proposition may be absolutely true, the proportion previously given appears exaggerated. Thus, from the statistics of M. Diday, bearing upon 158 cases, it happens that the syphilitic symptoms have manifested themselves:

Before the lapse of	1	month	since birth	86	times
,,	,,	2 months	,,	45	,,
,,	,,	3 ,,	,,	15	,,
,,	,,	4 ,,	,,	7	,,
,,	,,	5 ,,	,,	1	,,
,,	,,	6 ,,	,,	1	,,
,,	,,	8 ,,	,,	1	,,
,,	,,	12 ,,	,,	1	,,
,,	,,	24 ,,	,,	1	,,
				158	times

If, then, the chances are greatly in favour of the child who has not betrayed his syphilis before the end of the third month, it is not less true, on the other hand, that it may remain latent until the age of two years. Absolute security cannot depend, then, upon the age of the vaccinifer.

From what precedes, does it follow that it is necessary

* Séance de l'Académie de Médecine de Paris du 19 Mai 1863.

to give up arm-to-arm vaccination? No such idea is in our thoughts. As well might one say that it was necessary to abandon venesection because there had been unfortunate cases of blood-letting, or chloroform because there had been deaths from anæsthetics. We desire simply to arrive at this conclusion: that vaccination is a serious operation, of which the medical practitioner should scrupulously reserve the monopoly; that in place of being always, as was long believed, free from all danger in so far as concerned the transmission of syphilis, such transmission, although very rare, is always possible, but it is less in proportion as we surround ourselves with the most minute precautions for avoiding it; that in presence of such eventualities, the surgeon shall only be relieved of all responsibility on condition of having done his utmost to guard against all chances of danger or of accident.

Let us summarize: it is impossible to gainsay that the lancet of the vaccinator, whether it has been badly cleaned after being used for some other purpose, or whether it has been charged with syphilitic matter at the same time as with the vaccine from a badly selected vesicle, may inoculate syphilis with vaccinia. But to ensure that, a number of circumstances must happen, which a prudent operator will nearly always know how to avoid.

In order to admit that vaccine matter, properly so-called, might be mixed with syphilitic matter, it would be necessary to have demonstrated that the germ of vaccine and that of syphilis can exist together and live well in the same medium. But that has not been demonstrated, and thus cannot be affirmed. In order to allow of that, it would be requisite that in mixing syphilitic pus with vaccine and in inoculating this mixture, that we should be able to produce a single vesicle, enclosing both viruses.

Well; what we obtain in this case, if—as may happen—the two germs propagate themselves, is a vaccine vesicle and a chancre, appearing successively, the one first the other afterwards, and running their courses separately. There is the danger for the careless vaccinator. But if, in a contaminated subject, the arm of the vaccinifer bear no inoculable syphilitic production, and the lancet borrows from the vesicle only lymph deprived of blood, it is by no means proved that the transmission may still be possible.

If it were otherwise, cases of vaccino-syphilis would be counted by thousands. It is established, on the contrary, that in those countries where vaccination has long been obligatory and practised exclusively by special physicians, such as Sweden, Hanover, Hesse, Nassau, Wurtemberg, &c., vaccino-syphilis is entirely unknown. At any rate the prejudices of families are not less existent, and they have their grounds.

What satisfaction can it be to be subjected to these uneasinesses and to these unpleasant things? We have previously pointed it out. It is enough that the vaccinator shall take care to accept as vaccinifers only healthy and well-built children, and especially, seeing the difficulties which surround such selection, only to charge his vaccinating instrument with pure vaccine, innocent of any admixture with the blood or other fluids of the subject furnishing it.

This figured in the French edition of this book, when there appeared an observation of such a nature as to authorize, even to demand, greater strictness in our recommendations. Whilst insisting upon the statement that the "vaccinator should be especially careful only to charge his vaccinating instrument with pure vaccine, innocent of any admixture with the blood or other fluids of the subject who furnishes it," we fear we may have allowed it to be supposed that

such precaution rigorously observed might suffice, even if working with vaccine taken from a suspicious subject. This opinion indeed exists, and still finds many medical men to support it. Here is what, without doubt, will oblige them to modify it :—

Dr. Cory, of London, has just proved on his own person the folly of the widely spread belief that vaccine lymph from a syphilitic child, if such lymph be free from all admixture of blood, is in all cases incapable of conveying syphilis from the vaccinifer to the vaccinated.*

The experiments made by Dr. Cory were witnessed by a committee composed of Jonathan Hutchinson, with Drs. Bristowe, J. M. Humphrey, and Ballard.†

Three successive attempts did not succeed in contaminating the system, whilst the vaccinifers bore evident traces of hereditary syphilis. The first inoculation took place in 1877 or 1878, the fourth and last in 1881.

On July 6, 1881, Dr. Cory caused himself to be vaccinated with lymph perfectly free from admixture with blood, and taken from a vaccine vesicle on the arm of a child having a syphilitic eruption in the immediate neighbourhood of the vesicle.

The vaccine did not take ; but on the twenty-first day, July 26, Dr. Cory observed that two or three punctures had each become the site of a red papule. On August 10, Drs. Hutchinson and Humphrey saw the arm, and agreed on the syphilitic character of the papules. What followed confirmed the accuracy of their diagnosis. From this time it was proved (?)) that the inoculation of vaccine lymph from a syphilitic subject was capable of conferring syphilis on the inoculated. After the diagnosis of Messrs. Hutchinson and Humphrey had been confirmed, on the thirty-sixth day after the inoculation, Dr. Cory proceeded with all desirable precautions, to the excision of the papules. Nevertheless, on August 31 there appeared a roseola, whose spots showed themselves on the forehead, on the back part of the neck, behind and below the ears, at the lower part of the abdomen.

These experiments—if they have been well interpreted—and doubts have been expressed on that point (See Appendix, Note II.)—were of a kind to enforce the attention of medical men to the choice of their vaccinifers, and even to make

* *Journal of the American Medical Association*, Sept. 1884, and *The London Medical Record*, 1884. (See Appendix, Note II.)

† Supplement to the Twelfth Annual Report to the Local Government Board.

them prefer calf-lymph; besides, they were evidence against the preventive efficacy attributed to excision of the chancre as a prophylactic treatment.

3. There is then the first consideration that has to be disposed of. There is a second which it is not less necessary to pay attention to: I mean the relative poverty of human vaccine matter.

In countries where vaccination is compulsory—in England, for example—where every child, whatever the time of year, must not only, under penalty of fine or even of imprisonment for the parents, be brought to be vaccinated within three months after birth, but where the latter are liable to similar punishment if they do not bring the child back on the eighth day and allow it to be used as a vaccinifer, deficiency of vaccine is scarcely ever experienced, and from this point of view at least its sources do not require to be reinforced. But how often is it otherwise in other countries where, as in Belgium and in France for example, vaccination is entrusted to the judgment of parents? and how often do they forget to trouble themselves about it? There not only do the parents, when it is their fancy, neglect to have their children vaccinated, but what is almost as serious, looking to the transferable material lost, they may refuse if it be their good pleasure—and they do not hesitate to do it—to allow the smallest portion to be collected for the benefit of others. That is not all: there exists still in many places this prejudice, that it is dangerous to vaccinate children in the winter; hence an almost complete suspension of operations from the 1st of October to the 1st of May, that is to say, during seven months of the year.

We see the consequences of this state of things: If an

epidemic of small-pox appears in the winter, and with it the need of a large quantity of vaccine to meet the demands of revaccination, the virus becomes deficient, or at least its production is not in proportion to the demand for it. The doctors at the dispensaries, the lying-in charities, the institutions for human vaccination, have to perform prodigies of goodwill and activity; subjects become too few, and they are thus compelled to be less strict in their choice of productive subjects, must even distribute—who knows?—vaccine from revaccinations, which, nine times out of ten, merits no confidence, and when utilized for revaccinations creates a security as dangerous as all control over its results is impossible.

Thus, in parts where vaccination is not enforced by law, it is for the public utility that we should replenish the sources of vaccine by means which shall not be at the mercy of the populace.

We have already noted that in other parts this utility is not so great, since vaccinifers are rarely deficient; and that, in consequence, new methods of procedure would be but little likely to succeed on account of any insufficiency of Jennerian vaccine.

That is but one side of the question. There is another upon which we have already insisted. In countries where it is obligatory on parents to have their children vaccinated, the State also is under moral obligation to furnish to all families, vaccine which shall be beyond suspicion with regard to diathesic adulterations.

Such are the two failings inherent to the vaccination in use since Jenner's time, to which it was necessary to find an efficacious corrective by new measures. These correctives have been discovered in spreading the practice of what it has been convenient to call "*animal*

vaccination," a method which consists in inoculating the original vaccine upon young specimens of the bovine race, and using the product of this inoculation to vaccinate human beings. This product, besides enabling us to escape the danger of syphilitic adulteration, may very quickly be indefinitely multiplied, and create thus an illimitable source of vaccine matter capable of almost instantaneously supplying the most pressing and most extensive needs.

If the new method had only this single advantage, it would already have justified more than sufficiently the eagerness with which it has been seized upon. In vain has the most formidable opposition blocked the way. Nothing has succeeded, animal vaccination satisfied a want; public sentiment has very soon taken the measure of all obstacles.

4. Does the preservative power of vaccine diminish with time; in other words, may vaccine degenerate, and in the affirmative, should it be renewed, and by what means?

This question is one of those which the Royal Academy of Sciences of France, on the proposal of a Commission of which Professor Brechet was the secretary, opened to competition, in 1838, for a prize of ten thousand francs, to be awarded in 1842. That indicates the importance which, at that time already so long past, was attached to its solution.

It was only in the early part of 1845 that M. Serres communicated his report on the thirty-five essays that this competition brought to light: the prize was divided between MM. Bousquet, Fiard, and Steinbrenner. Each of them decided the question in the affirmative.

Although M. Brisset may be regarded with good

reason, from the energy and tenacity which he brought to its support (1818), as the true originator of the idea that vaccine degenerates by its successive transplantations from man to man; we must nevertheless not forget that, four years previously, an Englishman (Kinglake) had already expressed an opinion on the subject. In fact, in a publication dated 1814,* this author advised that, consequent on a certain number of reproductions in the human body, vaccine little by little lost its preservative power, in the same manner as that happens in those submitted to variolization, and recommended on that account, that, as often as possible, fresh lymph taken from the udder of the cow should be made use of.

Dr. Mayer,† again, reported that in 1817 the Sanitary Commission of the Grand Duchy of Baden, doubting the efficacy of the vaccine which they were then using in that country, by reason of the great number of transmissions from arm to arm that this vaccine had undergone during nearly twenty years, ordered that it should be renewed; for, said he, "it is useful from time to time to take vaccine from the cow itself, since human vaccine, by the admixture of heterogeneous principles (*sic*), must little by little lose its preservative force."

It was in his first memoir, read on May 28, 1818, before the Society of Medicine at Paris, that Brisset expressed his opinions on this subject. He said that on his return to civil practice he had found a great differ-

* "On the Altered Specific Powers of Vaccino and Variolous Matter" (*Med. and Physic. Journal.* By Fothergill and Want. September, 1814).

† "Annalen für Gesammte Heilkunde." 3e Jahrg. Heft i. 1827.

ence between the vaccine vesicles then existent and those which he had been in the habit of seeing before he embraced a military career (1809). He now found the vesicles much less developed, and their areolæ similarly much less marked.

It was, he said, this striking difference between the vaccine eruptions of the two periods that inspired him, in 1815, with the notion of a degeneration of the vaccine virus. He continued after this time to make researches, and compared, with that object, the eruptions of that time and the local and general phenomena which accompanied them, with the descriptions which authors of the earlier periods gave of vaccinia. It was in consequence necessary, he said, to renew the vaccine from time to time, in order to preserve its activity, by obtaining it from its source—the udder of the cow.

In his second publication* Brisset has rested his statement upon four series of proofs: 1st, proofs founded upon the analogy between the vaccine virus and other viruses, and the contagious miasmata; 2nd, proofs furnished by epidemics of varioloid which every year attack a considerable number of vaccinated subjects; 3rd, proofs drawn from the evident difference between the local and general symptoms then found and those of former periods; 4th, proofs drawn from the difference shown between the cicatrices of vaccinia to-day and the still existent cicatrices of vaccinia of the earlier years.

These conclusions have been attacked and defended with equal vigour on both sides; we look up the details

* Brisset: "Reflections on Vaccinia and Small-pox; having for their object the complete Extinction of Small-pox by means of Vaccination."

of the discussion in a book by Steinbrenner,* who has given a long account of it. In his mind, as in Bousquet's, doubt was not admissible; vaccine degenerates in passing through human organisms, and frequent regeneration of the vaccine lymph, by taking it from time to time from the cow's udder, is the remedy to oppose to this degeneraey.

This opinion has prevailed, and has been solemnly proclaimed anew in these latter times: in 1867, the Government having put to the Royal Aeademy of Medicine of Belgium the question if they were able to regenerate vaeeine, and that dying out, in what manner they might praetically obtain such regeneration, received to it the following reply:

"1st. The Academy has already reeognized the utility and even the necessity of regenerating or renewing vaecine, and it has not ehanged its opinion in this matter.

"2nd. A really praetieal method of securing this regeneration would consist in a large use of animal vaecination, derived from the inoculation of spontaneous cow-pox on animals of the bovine race, from which the produets of such inoculation would be constantly preserved by procedures recently introdueed into science."†

This theory corresponds to the ideas whieh have just

* Steinbrenner: "A Treatise on Vaeeinia; or, Histologieal and Critieal Researehes on the results obtained from Vaeeinations and Revaeeinations sinee the eommeneement of their employment, &e." Vol. in 8vo, pp. 844. Paris: Labré. 1846.

† "Report on the Question relative to the Renewal of Vaeeine by the aid of Animal Vaeeination, put, by the authority of a Commission, to the Royal Aeademy of Medieine of Belgium," M. Marinus, ceretary (*Bull. de l'Académie*, 1867, t. i. No. 3).

been expressed. Whatever may be the origin which we may attribute to vaccinia, whether attenuated variola or special virus, the human organism is certainly strange to it. It is not the soil on which it was hatched.

So much being admitted, let us see how this soil comports itself with respect to the variolar germ and the vaccine germ which may be introduced to it. The variolar finds there by right of previous occupation a marked welcome by means of general absorption, which restores it to the state of natural small-pox. With the vaccinal, it is no longer the same thing; in vain is it introduced there artificially, never does it show itself with all its attributes; horse-pox and cow-pox always convey it to man. Take it from one or other of these latter conditions and inoculate it on man: its first care is to descend a degree in the scale of virulence. Further, once descended, it never reascends to the superior grade unless under the condition of finding once more a soil propitious to such reascension, the body of the cow or that of the horse.

It is natural, that on this thankless soil, which is only a land of adoption, the vaccine germ should lose some of its activity; but if, as often happens in its migrations, it should as a last straw meet with sickly or unfavourable subjects, it will of necessity degenerate still more, and become in its turn the founder of a family whose members will be but little fitted to give origin to healthy stocks. Thus do stocks decline which, in spite of all the care bestowed on them, finish up by making unfortunate alliances. Thus explained, the so-called degeneracy of vaccine cultivated in the human organism is not a condition inherent to its existence; it is merely the consequence, almost fatal, of the course which we have made it take,

and of which the difficulties have not been successfully avoided. In brief, it is not the vaccine that degenerates, but the stocks that use or abuse it.

Animal vaccination, as it is now practised and commonly employed in certain countries, permits of constantly producing in man a breed of strong and healthy products. This is one of its most certain benefits, and, of all, assuredly the least contestable and the least contested. The decline of human vaccine, under these conditions, from whatever point of view we may look at it, is henceforth easy to avert.

CHAPTER II.

THE TECHNICS OF ANIMAL VACCINATION.

5.—I. *The Animals to be Used.* Up to the present time, vaccination termed animal has only been had recourse to with animals of the bovine species.

In the original edition of this *treatise* I had added: "Strictly if it came to being in want of it [animal vaccine], one might perhaps make use of animals belonging to the horse family, but under condition of causing the horse-pox, thus induced, to undergo a stage calculated to reduce its excessive virulence, by passing it through the organism of a calf before inoculating human beings with it." It is now no longer permitted to me to maintain this assertion, which I had founded on authorities which I was bound to respect. I can now state, with the assurance based upon experiments performed on twenty-four horses, that "*the organism of the horse is, for the culture of vaccine, a detestable soil.*" *

* "New Researches on the Origin of Vaccine." A communication

We may choose at will large or small animals; the latter, always more easy to handle, are generally preferred. We will first discuss them.

The calves, male or female, should weigh at least a hundred kilogrammes and be in good health.* A red or white coat, as a rule, coincides with a skin soft and free from black pigmentations, most favourable to regular observation of the vaccine eruption. Skins pigmented with black, lend themselves less readily to our purpose. Red and white calves are then those that we must choose; if we are reduced to the necessity of using black ones, at least we must insist that the region between the teats and the umbilicus, which is about to be used for the inoculations, shall be as white as possible.

Males are worth no more and no less than females; in the former, the scrotum is a region particularly sensitive to vaccine, which there develops almost better than anywhere else; but, on the other hand, the position of the genito-urinary organs interferes with the preservation of the inoculated region, by means of coverings from contact with the impurities of the litter. Amongst females, on the contrary, the folds which surround this region are sheltered from direct contact with the excreta. This is an advantage from another point of view, which the persons who collect lymph soon discover.

The stable should be well ventilated and of medium

made to the Academy of Medicine of Paris, October 10, 1883, by Dr. Warlomont (*Gaz. hebdomadaire de Méd. et Chirurgie*, Dec. 13, 1883).

* It has been said that during the first five or six months the animals are less likely to reproduce cow-pox. We are ignorant of the grounds upon which this assertion is based.

temperature, and during their detention here, the calves should receive, as their only food, eight or ten litres of good milk daily, according to size, besides one or two new-laid eggs. This nourishment conduces to their health, and gives to the tissues the appearance and other qualities which it is important to preserve for the use of the slaughter-house.

Too often the animals come to the stable, benumbed, unclean and distended with the water, that has been poured into their stomachs before their arrival at the market, to increase the weight upon which their price will depend. Hence come shivering fits, the beginning of diarrhœa, and often worse. To succeed, it is necessary that the animals should rest for a day or two after their fatigues, before being submitted to the operation of vaccination. The latter, under these conditions, will *never* be the occasional cause of any morbid state whatsoever, nor of diminution in the market value of the subject.

We must indeed not forget that, at the latest, the animal should yield all its harvest in the course of the sixth day, and that it may be killed on the seventh, before the possible development of suppurative fever, which thus never arrives until after the animal has been eaten. As a matter of fact, it does not suffer through vaccination, however numerous the insertions may be. It may suffer from the fatigues and ill-treatment of the journey, from the manœuvres of the dealer, from the change of stable, or on account of the separation from its mother, but vaccination alone is never the cause of any depreciation in it. This may be laid down as an axiom in the matter of responsibility.

What can be the reason then that calves are attacked

during the vaccinal period, with illnesses of a kind to make it pass through them unfavourably, diarrhœa and tympanites being prominent? Diarrhœa, if it be persistent—most often a light diet and some emollient draughts check it in a few hours—may arrest or at least delay vesiculation; tympanites which often accompanies it is one of its complications, and not less disagreeable. If it should begin when the eruption shows itself, the latter becomes modified at once; the vesicles become flattened, even to the point of disappearing or drying up completely. If they be full when the stomach trouble comes on, the skin, stretched like that of a drum, draws them, makes them smaller, and sometimes in a few minutes causes the disappearance of the whole of their contents. We must not dream of collecting the lymph under these conditions; on the contrary, we must treat the tympanitis and wait. Often a few hours suffice to allow the skin to regain its softness, soon followed by the return of the vesicles to their normal condition.

Animals vaccinated on the abdomen—that is the site of election—wallow in their litter, impregnated as it is with dejecta, soil in this manner both the seat and the products of the eruption, and when the latter has appeared, tear the vesicles by contact with the straw or hay. This is an inconvenience difficult to avoid, but the importance of which we need not exaggerate. As for being torn at their surface, the vesicles need lose on that account neither their contents nor their intrinsic qualities. But one should not on that account seek to avoid it (tearing) the less, as one may manage to do by placing some kind of pad over the abdomen of the animal, and by exchanging the ordinary litter for a floor, with an opening for allowing of the escape of excremental matters.

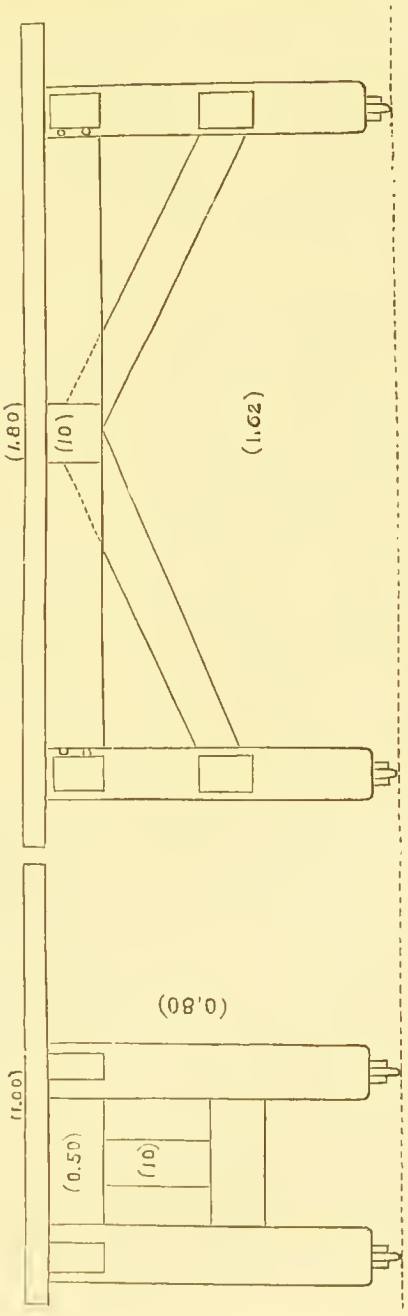
The vesicles are threatened in yet another way: the itching, which immediately follows the operation, induces the creatures to lick the small wounds, and thus to wash away the vaccine which has just been deposited there. Later on, the same irritation induces them to use the same method of subduing the irritation produced by the eruption. We avoid this means of sterilization or bruising, by applying to the beasts, as soon as they have been vaccinated, a kind of muzzle shaped like a willow basket, which they should retain during the whole time of their detention at the stable.

It is wise, for the same purpose, to obtain control over the tail of the animal, which is done by fixing it in a sort of frame, made of short sticks, rounded at both ends, and bound between these for a short distance; that prevents the animal from bending its tail, and from bringing the mouth near the region where the vaccinal insertions have been made. The basket is then unnecessary.

6. *The Vaccination of Calves.*—The day on which the animal is to be vaccinated, or at soonest the evening previous, for we must not allow the hair time to push out again, it must be shaved on the parts destined to receive the vaccinal insertions; a laborious operation, which we ought to entrust to a careful man, and for which it is necessary that the creature should be firmly fixed.

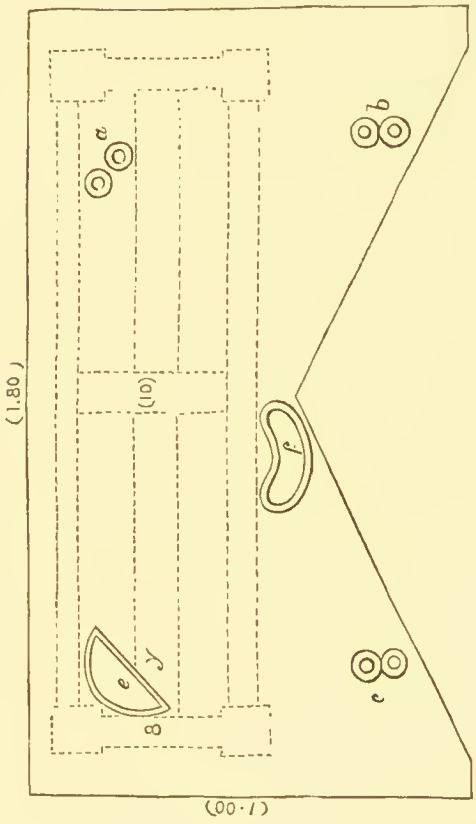
The table which we have had manufactured for this purpose, in imitation of that belonging to M. Lanoix, is represented (*see* Plate) on a scale of five centimètres to the mètre. To hoist the animal on it, we place him standing against the table, rendered upright by a tilting movement, and keep him there by means of a large abdominal strap. When we then replace the table in its

TABLE FOR VACCINATION OF CALVES.



To face page 108.

TABLE FOR VACCINATION OF CALVES.



To face page 108.

horizontal position, by means of a similar tilting movement, the animal finds itself stretched out, and it is now only necessary to fix him by straps placed for the purpose. The head is fixed by the rings (*a*), the two forelegs by the rings (*b*), and the left hind-leg by the rings (*c*). The right hind-leg is fixed, raised at the further end of a curved bracket (*y*); the whole inguinal region on this side is thus exposed, well stretched to our manipulations. The marks (*e*) and (*f*) represent excavations prepared for zinc vessels, ready to receive fæcal matters and urine.

To free the animal, we tilt the table again, this time to make it vertical, after having loosened all the fetters with the exception of the large central strap, which we only unfasten when the creature is upon its legs.

The operation of shaving is long and difficult. It is necessary first of all to cut the hair with scissors, then to lather the part with soap and hot water, and last of all to use the razor, a task which the agitation and movements of the subject render very irksome. Perhaps some day we may find some depilatory preparation capable of taking the place of the razor. This would be very desirable.

The surface to be denuded should be about as large as the crown of a man's hat, and reach from the inguino-mammary region towards the umbilicus. It is on this surface that the incisions or punctures destined to receive the vaccine will be made. The incisions, numbering from 80 to 100 or even 150, should scarcely go deeper than the epidermis; they are about a centimètre long, and are made in the direction of the axis of the animal, in order that, later on, when we come to make use of the vesicles, the spring forceps applied to them shall not be

forced off by the movements which lassitude or illness induce the vaccinifer to make, and which cause elongation of the longitudinal at the expense of the bilateral axis. The incisions are about two centimètres apart. When the operation is completed, the animal being stretched on one of its sides, they appear as a series of ladders placed side by side, about two centimètres apart, a distance which similarly separates their steps. To allow every facility for the expansion of the vesicles, it is useful to arrange the steps of neighbouring series a little crosswise.

As the line of incisions is made, we introduce the vaccine matter, whether it be preserved (which is always a last shift), or by preference, taken from an animal which has been vaccinated five or six days, and which, to serve this purpose, has been fixed on a neighbouring table.

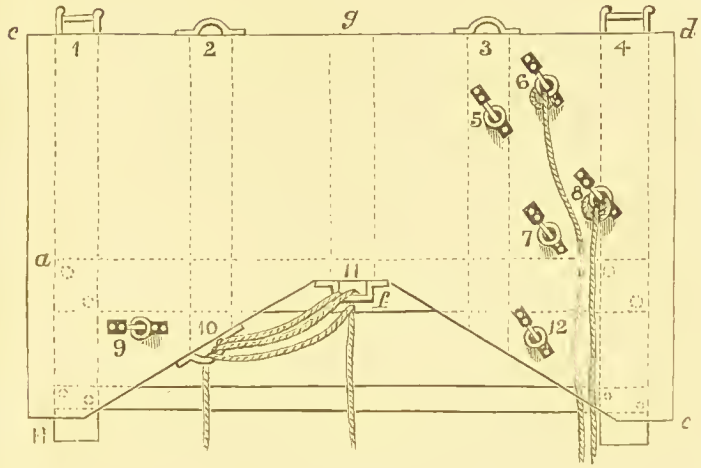
Punctures are made with a grooved lancet which is charged with vaccine and introduced obliquely under the epidermis. We may place these more closely together than we can the incisions, because the vesicles which result from them are always smaller than those which come from the latter.

7. Adult animals must be treated in a similar manner, which demands that we should use a very strong apparatus.

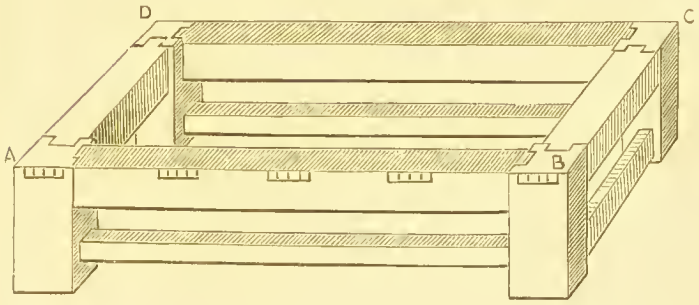
The tilting-table is composed of two parts* (*see* Plate). First, the under part composed of four pedes-

* Military Vaccine Institute at Antwerp. Report by the Chief Physician, M. Riemslagh.—Note on the operation known as "placing the cow on the table," by M. Deghilage (*Archives médicales belges*, Février, 1882, p. 114).

TABLE FOR VACCINATION OF ADULT ANIMALS.



VIEW OF TILTING PART.



VIEW OF UNDER PART.

To face page 110.

tals of elm, 10 centimètres thick and 50 high, joined above and below by cross-pieces, 10 centimètres broad by 4 c.m. thick. (The upper frame is 16 c.m. high.) Second, the upper portion of the table (the tilting part). This is 2 mètres and 40 centimètres long, 1 mètre 40 centimètres wide, and 4 c.m. thick; it is made of pitch-pine. The various planks are joined together by five cross-pieces of elm, with the aid of wooden screws. The cross-pieces are 5 centimètres thick.

Along the line A B are five very strong hinges. Ropes are needed, and are placed as follows :

1. A rope 6 mètres long and one centimètre in diameter is fixed by a rivet to ring 8. This must be applied to the whole of the right side of the cow; it serves to keep it against the table and to prevent it from moving forward.

2. A cord 4 mètres long, fixed to ring 6, will be attached to ring 8 (this rope serves to fix the head). After having made two figures of 8 in such a way that the resistance shall be midway between the horns, we pass the rope over the head to fix it ultimately to ring 8.

3. A rope 9 mètres long and 2 centimètres in diameter, which shall be held by pulleys 10 and 11, in such a way as to leave two free ends, each about 4 mètres long, which must be brought back afterwards to pulleys 2 and 3. These two ropes serve to lift the belly of the cow, and to hold it against the table during the operation.

4. A leather strap passing through rings 5 and 7, to act as a collar, keeps up the neck.

Fetters are also used. Their object is to keep the four

legs under the belly of the beast, which loses its equilibrium, and in consequence all power, for it has no point of support. The fetters are similar to those used in veterinary medicine in slaughtering animals. They are composed of four manacles, jointed at their centre to an iron ring. They are applied to the four legs immediately above the hoof. A rope attached to one ring passes through all four, in such a way as to form an ovoid, which becomes smaller and smaller in proportion as we draw upon it. A long board is also needed to place the right hind-leg in the special position described later on.

The Operation.—The upper part of the table, with its ropes arranged, is placed vertically.

A bundle of straw is spread out over the table with the object of hindering the cow from slipping.

Five assistants are necessary; we will designate them by the numbers 1, 2, 3, 4, and 5. The cow is led against the table, its head opposite rings 5, 6, 7, 8.

Assistant 1, by means of the rope attached to ring 8, holds the cow firmly against the table and prevents it going forward.

Assistant 2 fixes the horns and head to rings 6 and 8. Assistants 3 and 4 place the cords 10 and 11 into the pulleys 2 and 3, and fix the animal against the table. Cord 8, now become less useful, may be let go, and we then pass it twice round cords 11 and 3 and 10 and 2, we next place it once more as at first, but low enough to support the fore and hind quarters during the rocking movement.

This is the time to fasten on the fetters. We begin with either of the two fore-legs. These two fetters are easily placed. It is more dangerous and more difficult to

place the hind fetters. To avoid kicks, it is prudent to stand beside the belly of the beast. We may also for this purpose raise with a strong lever one of the fore legs. We will begin with it doesn't matter which hind leg, but we must take care to place that fetter to which the rope is tied, on the left hind leg, for the hind right leg must presently be freed to be placed in a special position. We then pass the rope through the four rings of the fetters. We adjust the strap to the neck (ring 5—7).

We may now proceed with the tilting movement. The five assistants are then placed as follows :—

1, holds rope 10—2 and fetter 1 ;

2, holds rope 11—3 and fetter 4 ;

3, holds the cross rope 8 and vigorously draws the beast against the table ;

4, the strongest assistant, holds the tail and pulls upwards with all his strength, for the hind quarter, which is the heaviest and the least supported, tends to slide downwards.

5, the assistant who draws the cord through the fetters, controls the tilting movement at the moment when, drawing on the cord through the fetters, he sees that the cow is about to lose its equilibrium. The latter now offers no resistance. This manœuvre, when it is well executed, is easy, free from danger, and very expeditious.

We can place a cow on the table in less than five minutes. Cords 10—2 and 11—3 are respectively attached to manacles 1 and 4.

Cord 8 is tied across the table. The fetter-rope passes into ring 12, and is also tied across the table.

To lay bare the mammary region we seize the right hind leg in a notch in the long-board, at the spot where

the fetter is placed. The rope passes under the left shoulder, then returns to the foot, immediately over the noteh in the long-board. We draw the eord, after having freed the right leg from its fetter, and we fix it firmly to pulley 3. The object of this manœuvre is to bend the limb as much as possible, so as perfectly to lay bare the mammary parts. The hoof should be at the level of the shoulder-joint.

The manœuvre for letting the eow down is much shorter and more easy.

We free the limbs from their fetters, beginning with the right hind limb. We detach the head, neck and all other ropes successively. The cow, thus disengaged, remains perfectly quiet. When we tilt the table the five assistants are placed as follows :—

No. 1 at the head to support it, and afterwards to prevent the cow running off; two assistants at pulleys 2 and 3 to raise the table and support the cow by means of ropes 10—2 and 11—3, which rest in pulleys 2 and 3 until the beast is upon its feet.

The two others are plaeed at cross rope 8 and at the tail; they pull vigorously upwards and away from the table to keep up the hind quarter, whieh tends to descend too quickly.

One does well, before letting the eow down, to gently rub its limbs, benumbed by the uneomfortable position in which they have been kept.

CHAPTER III.

DEVELOPMENT OF THE VACCINE ERUPTION IN THE BOVINE SPECIES.

8. At the end of about forty-eight hours, if the inoculation is to be successful, each incision is surrounded by a light-red border, which twenty-four hours afterwards rests upon a swelling whose size increases rapidly, to come out, at the end of the fourth or fifth day—depending on climate and season—in vaccine vesicles.

These vesicles are shaped like an elongated coffee-berry, with a longitudinal cicatricial depression, corresponding in extent to the incision of insertion, surrounded by a zone of transparent silvery-white, itself encircled by another red zone. According to the extent of pigmentation of the skin at the point of insertion, these vesicles present, at their centre, a tint sometimes bluish, sometimes yellow or orange, sometimes red or violet-coloured. The little swelling keeps growing during the seventh and eighth days; the transparent zone becomes white, chalky, then yellow; on the subsequent days, the vesicle becomes purulent, then dries up and is changed into a dark scab which only falls from the fifteenth to the twentieth day.

When we have operated by puncture, we obtain rounded vesicles, following, during their development, the course which we have just described, always with this difference—which may be explained by the fact that, in this instance, the resistance offered by the epidermis has to be overcome, while in the other, we have operated

with an uncovered surface—that the eruption is about twenty-four hours later. This circumstance may be made use of to obtain, on the same animal, vesicles in two stages of development, which cannot but be of advantage.

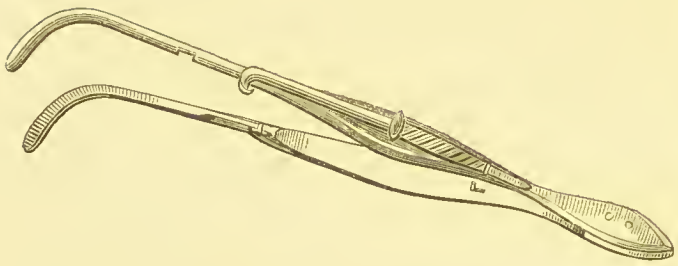
For ordinary purposes, we use incisions in preference to punctures; they are earlier, more productive, and admit of being more easily enclosed and isolated by the curved clasp of the expressing-forceps.

The vaccine is only fit to be used, as it is, during twenty-four hours; to use it advantageously, either for vaccination or for preserving, it is necessary to choose the opportune moment. But this moment, which experience alone teaches us to recognize promptly, and is that during which the pale areola has its transparent appearance and silvery colour, varies according to the temperature: in summer it most frequently arrives during the course of the fifth day, in winter during that of the sixth.

There may be a margin of twenty-four hours during which the matter remains transparent, but we must not reckon upon it; the most favourable moment approaches most nearly to that when the silvery tint has just *commenced* to show itself, under the guise of a little white border, parallel to the incision or rather to the cicatrix which replaces it.

In the vesicles of human vaccine, the fluid matter is distributed in such a way, throughout the parenchyma of the little swelling, that it transudes in the form of clear droplets as soon as we have slightly pierced, with a lancet or even with a needle, its outside envelope. In those of animal vaccine, it is not so; one may cut the external cuticle considerably, without seeing the least particle of

EXPRESSION FORCEPS.



To face page 117.

lymph ooze up. It is necessary here, then, for gathering it, that we should force out the lymph by compression of the swelling. We have had made for this purpose a curved forceps, exercising a pressure which is maintained by means of a grooved catch. This forceps should be placed in such a fashion that its convexity presses, not the tissues situate beyond the swelling, but the base of the latter alone; the upright parts of the forceps limiting the tumour itself on each side, prevent the fluids of adjoining tissues from running in at the sides (*see* Plate).

The vaccine fluid is made up of two chief constituents; a vehicle, which is nothing but serum, and solid bodies, amongst which are the special granulations which represent the virulent power. This fact, placed beyond doubt by M. Chauveau for human vaccine (38), has been rendered equally beyond all dispute for animal vaccine, by the experiments which MM. Carsten and Cœrt* performed at La Hague with the aid of M. H. W. Pareau, and of which we here give a *résumé:*

These authors report that "animal vaccine was filtered through some Bergelius paper and through little plates of porous porcelain, by the aid of a pneumatic machine. Microscopical examination teaches us that this paper retains epithelial cells, fibrinous coagula and other solid particles, but that it allows those *globular molecules* which are found in large quantity in vaccine lymph, and which we take for micrococci, to pass through. The porcelain plate transmits neither these molecules nor any other morphological particle.

* "Animal Vaccination in the Low Countries: Some Provisional Experiments performed at the Vaccine-farm at La Hague, on the Special Qualities of Vaccine-virus." By Carsten and Cœrt. (Congrès Médical d'Amsterdam, 1879.)

"We have repeated these filtrations in several ways, and we have been able to determine, each time, that inoculations performed on calves, with the aid of the serum deprived by filtration of its globular molecules, gave only negative results. When, on the contrary, these moleeules had been kept in their vehicle, the inoculations were constantly sueeessful.

"We have mixed and washed the vaccine with much water, to separate these molecules from other solid partieles which might adhere to them, and which we might have eonsidered equally endowed with some virulent property, then we have eaused to pass through the porcelain plate all that the latter allowed to pass through it. Inoculation with the matter left on the filter has still been followed by a positive result.

"It is evident that here, as in human vaccine, the virulence is inherent to the globular moleeules."

The identity theu is complete, as to the uature of the aetive prineiple of vaccine, whether it come from the cow or froun the child. It is in both cases a typieal granulation suspended in serum. The seruun only differs a little: it is more plastic in the cow, perhaps because the vaecine obtained from it has had to be *expressed* by force which may have driven forth more fibrin-forming bodies; henee a greater tendeucy to coagulatiou, which renders more diffieult the preservation of animal vaeeiue in the liquid state, or rather its expulsion from the capillary tubes into which it has been introduced.

CHAPTER IV.

COLLECTION AND PRESERVATION OF ANIMAL VACCINE.

To procure a supply of human vaccine there is but one method: to open the external covering of the little vaccine swellings on the seventh day of their development, and wait.

We then observe a portion of the contained serum ooze up, containing a more or less considerable quantity of the specific virulent granulations, which it has taken up in its passage and in washing against the trabeculæ.

For the collection of animal vaccine our intervention is less passive; the vesicles may be compressed, scraped, excised, in order to make them give up the whole of those concealed constituents which are needed for the propagation of the vaccine. Hence the various modes of preparing animal vaccine, absolutely unknown where human vaccine is concerned, and fertile in new resources, which we are about to describe.

9. I. *Liquid Animal Vaccine.*—A. *Tubes.*—The vesicle is seized between the prongs of the expression-forceps, which at once forces out a little serum, mingled with blood and external detritus, such as the vaccinal scab, necrosed epithelium, impurities arising from the litter, &c. The whole of this first spurt is rapidly wiped off by a touch with a handkerchief. Then the vaccine lymph wells up gently, in the form of a transparent viscous fluid. If at this moment we place in the little pool thus formed the end of a tube open at both ends, the liquid runs in and soon fills it.

This method is elementary; unfortunately tubes thus filled soon become useless; in a few hours a fibrinous clot forms, which it is difficult and often impossible to move. Something has happened to change the quality of the contents. This vaccine deserves no confidence.

We must obtain it in some other way. We place in a glass or porcelain capsule, or some other receptacle, the fluid contents of a certain number of vesicles, which we have forced out by means of the expression-forceps, and we stir in some drops of distilled water added to an equal quantity of glycerine; we mix, we remove the detritus, residuum, coagulum, blood globules, fragments of epithelium, &c., then we cause to pass into the tubes the liquid which, thus cleansed and freed from its chief coagulants, rushes into them and keeps well.

It matters little whether we make use of cylindrical tubes, or of tubes with a central enlargement.

Vaccine prepared in this way preserves its limpidity and is safe from any putrid change. Observation, however, has taught me that though virulence may often be maintained for a long time, this longevity is far from being the rule. In the great majority of cases it diminishes rapidly, to cease altogether in about five or six days. We must no longer lose sight of the fact that this vaccine is diluted by the addition of a certain quantity of watered glycerine, and that it must be used freely by means of scarifications, if we wish to range on its side the greatest possible chances of success. We may indeed avoid this inconvenience by neglecting such addition, but we then cease to be guarded against the decomposition which always happens after a little time, even in tubes to all appearance hermetically sealed.

B. *Glass Plates.*—Some people ignorant of what

actually happens in vaccine lymph enclosed between such plates, on account of having occasionally found it damp after the lapse of several days, considered them a means of preserving vaccine in a fluid state. This is a serious mistake, concerning which we have already explained ourselves. Glass plates as a means of preserving vaccine in the liquid state belong to the past, and ought to be relegated to it, to give way to other more certain and more practical methods.

10. II. *Dry Animal Vaccine.*—A. *Ivory Points.*—These are plates square at one end, pointed at the other, 5 centimètres long, 6 millimètres broad, and as thick as a playing-card. To charge them we seize the vesicle with the pincers whose arms we press closely together, then we wait a few moments; then we place the plate, first on one side, then on the other, into the matter which comes to the surface of the vesicle, in such manner that it may be coated with vaccine on both sides for the length of 1 to 2 centimètres, starting from its pointed extremity. Afterwards we place it upon the edge of an overturned dish, the lower end resting upon the raised circular border which we find there, the point directed towards the centre of the dish; when it is thus sloped, it is towards this point that the matter with which it has just been coated runs; we thus place thirty or forty in order, one beside the other on the base of the same dish, and then expose the latter either to bright sunlight, or to the radiation of a fire giving a heat of similar intensity. In a quarter of an hour the vaccine is dried by the evaporation of its fluid constituent, and the "point" may be used.

If the ivory be not very hard and well polished it becomes penetrated by the vaccine; in this case it is

wise to coat it previously with a layer of mucilage of gum-arabic, which we allow to dry thoroughly before applying the vaccine to it. If a first layer of vaccine does not seem sufficient, we may, after the drying is complete, lay on another. Then if we desire to preserve the points from the action of the air, with the object of prolonged preservation, we clothe the portion supplied with the vaccine with another layer of gum-arabic, and we cover the whole with tin-foil.

Points thus prepared, as a rule, retain their activity for a long time ; which is explained by the liquid part in its evaporation having freed the solid portions or vaccine granulations from elements favourable to putrefaction.

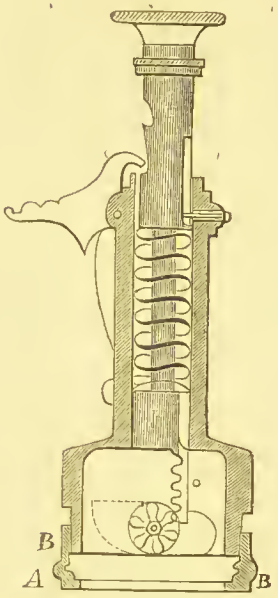
To make use of the points, we must open to the vaccine a wider door than punctures can offer, and for that we must act as follows :—

Place on one, then on the other surface of the ivory point a drop of lukewarm water, which is left there until the vaccine is thoroughly softened. Make then at a distance of 1 millimètre from each other two or three scarifications about 4 millimètres long, involving only the epidermis, or *better* a single circular incision with the aid of the trephine-vaccinator. When blood flows, allow it to cease, then rub the vaccine-charged point over the well-stanched wound. If blood now mixes with it, collect the whole over the incisions and allow to dry.

Vaccination by scarifications still meets with a few opponents. They charge it with being painful and difficult, with causing much bleeding and large vesicles ; with being a source of fright for subjects and for witnesses.

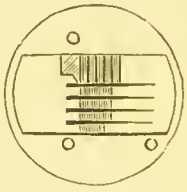
It is to satisfy these that Dr. Umé contrived his *vaccine-scarificator* (*see* Plate). This instrument consists

DR. UMÉ'S VACCINE-SCARIFICATOR.





VIEW OF CAP A B.



VIEW, CAP A B. REMOVED.

To face page 123.

of four blades fixed upon a horizontal axis, to which may be given an alternating rotatory movement by means of a toothed wheel attached to the stem, and controlled by a rack. The movement of the latter from above downwards is given by the operator, by means of slight pressure exerted on a knob which finishes off the upper part of the instrument.

Movement from below upwards is determined by the reaction of a spiral-spring, compressed by the descent of the stem. Fixation between the two movements is assured by a catch fitting into a notch placed near the upper end of the rack-stem, and maintained in this position by a spring-blade; it is upon this that we press by means of a lever adapted to the catch, in order to free the latter from the notch, and thus allow the spiral spring to act.

The depth to which the blades penetrate is at the choice of the operator, thanks to a plate in which are cut openings for passage of the blades, and which may be brought nearer to, or removed further away from, the axis of rotation of the latter, by aid of a ring adjusted inside: this moves on a screw placed for that purpose on the external surface of the box which encloses the axis of rotation as well as the blades.

Practice with this instrument is very simple. To make use of it, the operator presses the knob which forms the upper end of the rack-stem, until the catch is fixed in the notch; the apparatus thus arranged is placed on the arm.

Slight pressure made on the catch frees it from the notch, and the stem, thanks to the spiral-spring, rises quickly, dragging with it the blades, which, describing the arc of a circle, produce the scarifications.

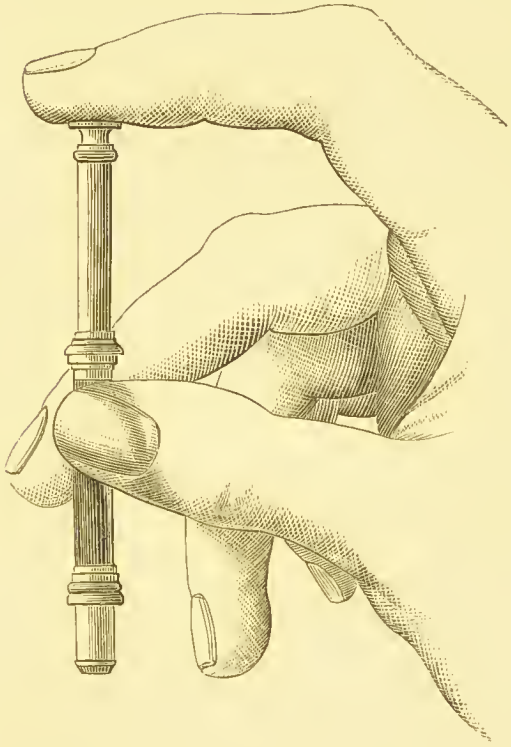
We have borrowed M. Umé's notion in constructing a lighter apparatus which we have called the vaccinator-trephine (*see* Plate). This consists of a circular blade, 2 millimètres in diameter, enclosed in a circular sheath. A rotatory movement is given to it by the play of an internal spiral. The instrument being accurately applied to the well-stretched skin, it is only necessary to press the end of the forefinger vigorously on the knob, to set going the blade, which traces a circular furrow of a depth measured by the projection given to the blade, a projection increased or diminished by turning backwards or forwards the protecting ferrule. In the case of little children, with fine skins, the blade should scarcely be passed below the rim of the sheath. The incision made, the vaccine is applied in the ordinary way.

It has been said that animal vaccine must be less active than human vaccine, since it has been necessary to invent a new method of introducing it. A mistake. Vaccination by scarification is not a new procedure; for many years it has been used in England and in Belgium. Besides, it was not designed for animal vaccine alone; every vaccination *with preserved vaccine* should be made freely on a large surface if we wish to assure success.

B. *Vaccine Powder.*—In Italy, Dr. Frappoli has attempted to preserve the vaccine vesicle in a dry state, and M. Ciaudo* states that he has obtained very good results with vesicles dried from 110 to 130 days. Dr. Verardini has undertaken this operation with the aid of

* Ciaudo, "Concerning Calf-lymph. A Comparative Study of Animal and Human Vaccine." A memoir rewarded by the Academy of Medicine of Paris in 1879. Pp. 120, with illustrations. Paris: Ad. Delahaye. 1882. P. 21.

WARLOMONT'S VACCINATOR-TREPHINE.



To face page 124.

the bell-glass of a pneumatic machine, under a pressure of from 10 to 15 mm. of mercury, as is done with substances destined for elementary organic analyses. He is able thus to dry at once at least 300 vesicles, and the operation lasts only five or six days. It has been proved that the vesicles are better preserved in proportion as the temperature is lower; this is kept, by means of ice, at 6° above zero. Then we have heard* that M. Pessin has been able to prepare a vaccinal powder, by reducing to dust fragments of vesicles impregnated with glycerine, and dehydrated in one of the machines for desiccation which are met with in chemical laboratories.

Convinced that substances mixed with glycerine could not be dried—there must be some mistake in the report which we have read of the *modus faciendi* of M. Pessin, of which we have just spoken—we gave our attention to vesicles cut up into small fragments, which we had submitted to rapid dehydration in an apparatus *ad hoc*. At the end of two or three days, these fragments could be reduced—as Dr. Margotta, of Naples, had already found—to a fine powder, which we preserved *in the dry*, in tubes closed only by a cotton-wool pad, so as to allow the vaccine microbes to enjoy a certain amount of air and moisture, favourable to the preservation of their latent energy.

This powder ought to be able to preserve its activity for a long time. Without being yet able, for want of sufficient experience, to pronounce either on this point, or as to the best mode of using the powder thus preserved, we will state what we know on this last matter at the time of writing these lines: introduced as it is and

* *Gazette Médicale de Paris*, 1882, No. 33.

dry, into the incisions which we make in calves for vaccination by ordinary methods, the powder has seemed to us to develop with difficulty, and success has not been the rule. When, on the contrary, we have given to the microbe the means of passing from a latent state to one of active life, by allowing the powder to macerate in glycerine water for twenty-four hours, we see the particles regain their size, fill out more and more, in the same way as foods dehydrated with a view to preservation, fill out when thrown into water. The preparation thus obtained has given us the best results, although we made use of powder already more than three months old.

III. *Animal Vaccine in Pulp.*—A. *The Vesicle alone.*—In the early days of animal vaccination, this was the procedure particularly recommended; the vesicle was cut out, seized with a pincers for the purpose, the lower surface being turned up, and scratched with a lancet in such a way as to bring out the lymph, which was inserted, either by puncture or by being deposited on scarifications made in the skin. There was nothing to say against this method, so far as the results were concerned;—like an execution, it was merely the brutality of the practice: the wound, made in the abdomen of the vaccinifer, from which the blood flowed in waves, and the shred of skin, scarcely attractive to look at, placed under the eyes of the vaccinated—but only against the well-understood condition of having to use it on the spot. So soon as the vesicle was placed on one side for purposes more or less remote, crowds of inconveniences presented themselves: the vesicle shrank rapidly, and, a much more serious matter, began to decompose within a period whose duration could never be decided, which might thus be the starting-point of the most serious accidents. Let us

recall one instance: In 1879, the doctors at San Quirino d' Orcia, inoculated thirty-eight infants, all less than twenty months old, with vaccine derived from vesicles which had been sent them from Rome, and which were not used until five or six days after they had been excised. It was summer-time, and the vaccinators never allowed themselves to be warned by the musty smell which came from the vesicles. Whilst waiting for the result of the vaccination, these unfortunates found that they had inoculated septicæmia, which betrayed itself in most of the vaccinated by large inflamed swellings, undermining the muscles, penetrating into the joints, and accompanied by convulsions, &c. The disaster was frightful.

This method is nowadays completely abandoned; or at least those who still use it take care to exercise certain precautions, of which the chief is to place the vesicle in glycerine, immediately after having cut it out, and to keep it there until the moment of using. To hasten the process we place this in a hollow scooped out in the middle of a thick plate of glass, which we cover over with another plate, also of glass. These two plates are kept together by paraffin or some other adhesive agent.

B. *Glycerinized Pulp.*—This method, which consists of using the whole vesicle, freed from irritant substances with which it may be smeared or infiltrated, is evidently the most logical, since it yields to the vaccinator all the virulent contents which the vesicle may enclose. It is also that which nowadays, in practice, numbers most partisans. Perhaps we may be astonished at the long time that it has taken for its introduction; the imperfection of the methods made use of must alone be blamed.

The Animal Vaccination Committee of the town of Milan seem first to have introduced this mode. This is how this preparation is made :—They excise the skin with the vesicles, they fix the shred upon a small board with a strong pin, and scrape the vesiculated surface so as to get rid of all detritus. "We make of it," says M. Ciaudo (*loc. cit.*), "a homogeneous paste, adding half a gramme of chemically pure glycerine for each vesicle employed. We place the vaccine thus prepared in a little glass bottle, which we half fill with glycerine, which serves as a stopper and preserves it from contact with air. We keep the phial in a cool place, and when we wish to take out the vaccine, we have only to take up the glycerine and drop the paste on to the open end of a goose-quill cut obliquely, which, for expedition, we enclose in another quill a little stronger."

This preparation is very active, and keeps for a long time; those who introduced it into practice have made indisputable progress. It requires, however, to be perfected, with the object of removing from it the irritant element which, in the vaccination of children, too often manifests its effects in inflamed vesicles.

In Holland a method founded on the same principles is employed. The pincers being applied, they scrape the vesicle with a bistoury, and place between two glass plates the detritus thus raised, after having added some glycerine to it.

Similarly it is upon these principles that is based our own process; only we first, by a species of decortication, cleanse the vaccine vesicle with the greatest care from every possible impurity with which it may be contaminated, and particularly from the so-called vaccine scab, which, though it may contain a considerable

proportion of virulent principles, which we may regret being obliged to sacrifice, is in great part made up of foreign bodies. That done, what remains—that is to say, the core of the vesicle itself freed from all impurity—is reduced, by a special method, to a thin mass; it is then treated with glycerinized water, and we introduce the emulsion thus obtained into cylindrical tubes of amber-coloured glass, which we seal in the cold. Should it be desired to make a pomade of it, we incorporate it with an appropriate aseptic excipient, as we now do. The vaccine pomade is preserved in small bottles of amber crystal, stoppered with emery. It keeps in these so well and so long that we no longer hesitate to advise vaccinators, especially during epidemics, to provide themselves with similar phials—indeed, to carry them habitually in their case for use at times of need. One or more vaccinations performed, we replace the stopper, and so keep the phial ready for new eventualities. This emulsion and pomade have not been found to fail during the month after their preparation, and we have been able to send them intact to the most distant destinations.

12. *Appreciation.*—For the fourteen years during which I have directed the State Vaccine Institution in Belgium, we have endeavoured to improve the modes of culture and preservation of animal vaccine. Nothing had been done to this end when we began this work. We approximated the tube to the open vesicle, and it gave what it was able. A little later came the expression-forceps; the vesicle after that gave forth all we asked of it—sometimes even more—but the fluid obtained soon coagulated in the tubes, and no good was done. Later still, thanks to a little glycerinized water, we dropped on something better. The matter no longer putrefied nor coagulated,

but it was *diluted*, and experience soon showed that this preparation hardly retained its activity longer than five or six days. However that might be, a first advance had been accomplished. For the interior of the country, where the postal service is rapid, the vaccine arrived early enough when used as soon as it arrived, as the instructions accompanying each parcel expressly recommended.

This result, although it did not come up to the ideal, was nevertheless considerable. The change furnished by animal vaccine, even under these conditions, sufficed from the beginning to fulfil its *rôle* of reserve, the only one to which it aspired.

It was not less necessary to continue the search. We then thought of using for calf lymph the ivory points which had long been used in England for the preservation of human vaccine. This was altogether a revolution. The employment of dry vaccine involved a reform in the *modus faciendi;* the traditional puncture had to give place, not quite without a struggle, to multiple free scarifications. Nevertheless, the reform worked; ivory points made their way, not without some objection. It is to them, in fact, that we owe the possibility of stating * that the vaccinations and revaccinations, performed in 1870 and 1871 by thirty-six Belgian doctors, with vaccine on ivory points delivered by the State Vaccine Institution, gave: 1st—in 500 cases of vaccination, 479 successes, or 96 per cent.; 2nd—in 5,425 revaccinations, 3,419 successes, or 62 per cent.

This proportion, nevertheless, whether due to special medical care or to a privileged series, did not keep up. We have recently seen in what fashion, and to what extent, it is nowadays surpassed.

* *Bulletin de l'Académie Royale de Médecine de Belgique*, 1871, t. v. No. 7.

The vaccine *emulsion* and *pomade* enjoy an activity nearly approaching that of *living* vaccine, and keep to that extent during the whole of the first month. During the whole of the second month this activity is slightly enfeebled; it is far from being entirely extinguished in the third.

We do not think it possible to go much beyond that.

* At the moment of printing the original edition, a letter from Dr. Allard, attached to the African Association, gives the result of vaccinations that he performed at Vivi (Congo) on the 31st of last December, with tubes of our vaccine emulsion, prepared and forwarded on October 6th previous—that is to say, eighty-six days, and through an excessive temperature (57·5° in the sun, 32·5° in the shade, 26° at night). These tubes during the voyage were kept from any possible contact with air, but for all that it had not been possible to preserve them from a temperature rising, even in the cases and trunks, to from 28° to 30°.

Notwithstanding these unfavourable circumstances, the result has been relatively satisfactory: "Of twelve patients vaccinated with your *emulsion*," writes Dr. Allard in a letter dated January 7, 1883, "it has only been possible to inspect nine to-day, amongst whom there are six successes and three negative results—that is to say:

1st.	26 years old,	6	insertions by scarifications,		3	vesicles	
2nd.	23	,,	6	,,	,,	1	,,
3rd.	13	,,	6	,,	,,	2	,,
4th.	20	,,	6	,,	,,	4	,,
5th.	15	,,	4	,,	,,	4	,,
6th.	15	,,	4	,,	,,	2	,,
7th.	15	,,	4	,,	,,	0	,,
8th.	28	,,	4	,,	,,	0	,,
9th.	26	,,	4	,,	,,	0	,,
			44			16	

Total, 16 vesicles from 44 insertions, or about 40 per cent. This result is probably lower than the reality; three subjects are deficient, and perhaps Nos. 7, 8 and 9 had previously suffered from small-pox."

The problem as to the despatch of vaccine to the greatest distances, with preservation of its virulence, is therefore solved.

CHAPTER V.

DISCUSSION OF OBJECTIONS MADE TO ANIMAL VACCINATION.

It remains to us to overthrow the objections, however stupid they may be, that have been made to vaccination *termed* animal.

13. It has been said that calf lymph such as that which we cultivate is not cow-pox, because it has passed through a series of cows, or, still worse, through a series of heifers, and because the insertion of the virus has been made on the skin of the abdomen and not on the ordinary seat of inoculation—the udder (Bousquet).

But first, is the udder indeed the site of election chosen by Nature for the external manifestation of general, natural, spontaneous cow-pox? or, rather, do we not meet the vaccine swellings there by chance, because the hand of the farmer, after having dressed horses attacked with horse-pox, milks the cows and deposits the germs on the nipples? or, better still, because the excoriations resulting from the milking have served as a gate of entry to the germs floating in the atmosphere?

Besides, what matters it? And this is the most interesting part: when Jenner had transplanted the virus from the eruption on the bovine race to the human species, to both sexes and to all ages, he caused it to undergo a very different expatriation. And then, once installed in man, has not this virus traversed millions of organisms without losing the preservative power which everybody agrees to recognize in it? Why should it be

otherwise with cow vaccine cultivated on the cow or the heifer?

In a word, the argument would only be worth considering on account of its curiosity, and we will say with M. Lanoix: "We should go too far if, pushing these topographical exigencies to their extreme limits, we applied them from the heifer to woman."

The adversaries of animal vaccination have, from the beginning, brought forward the plea of inexperience. They did not then desire that it should be practised, because, according to them, twenty years must have passed in order that we might be able to judge of its preservative qualities. That was exercising precaution. M. Lanoix has replied to them that, on this point, Neapolitan experience nearly half a century old gave him complete assurance. "For a score years," said he in 1866,* "epidemics of small-pox in Naples have never been very serious, and it is believed by the inhabitants that persons vaccinated with animal vaccine are nowadays not exposed to the dangers of small-pox to nearly so great an extent as those who, in their childhood, have been vaccinated from arm to arm. It is in the Neapolitan army that epidemics have always raged with most violence. Might we not discover the cause of this in the fact that nearly all the soldiers, strangers to the city of Naples, had in their childhood been vaccinated only with human lymph?" For our part, we wrote the following in 1879:†—"Does animal vaccine preserve from small-

* "La Vaccination Animale." A memoir read in part to the Academy of Medicine of Paris on May 15, 1866, by Dr. Lanoix. (*Gaz. hebdom.*, May 25, 1866.)

† "Conference on Animal Vaccination, held at London on December 11, 1879." By Dr. Warlomont, Brussels. Manceaux. 1880.

pox in the same way as human vaccine?" Until now, no one has disputed it. We will limit ourselves to recalling what we published five years ago on this subject. "Amongst more than *ten thousand* children vaccinated at Brussels, from 1865 to 1870, from the cow to the arm, and exposed to the terrible epidemic which, in 1870 and 1871, terrified everybody, *not a single one has been described,* to my knowledge, as having been attacked by the scourge. The same immunity has been the good fortune of those numerous persons whom I revaccinated, who at the same period lived at places where the epidemic prevailed."

Three years later, in 1878, desiring to make a full investigation into the matter, at the sitting of the Belgian Academy of Medicine held on March 30, we, with this object, interpellated our colleagues as follows:—"I have previously said that no such case has been described to me. I repeat it, and hitherto not one of the numerous doctors whom I have interrogated on the subject has contradicted me. Has there been no such case? It is very improbable. However that may be, I appeal to the hospital physicians and to the public services to make clear this fact, which, on account of the conclusions to which it leads, demands accurate verification."

This appeal has remained, and remains, without reply. Such a silence, we believe, speaks most eloquently in favour of a method of which we have made ourselves the most fervent advocate.

Three more years have passed since then, and the situation has not changed. The reservations made in 1865, demanding an experience of twenty years, are thus about to be demolished. Animal vaccination is in its

eighteenth year, and it never yet for a moment failed us.*

14. Once more, it has been said that human vaccine and animal vaccine were two distinct things; that Jennerian vaccine was spontaneous cow-pox which had been inoculated on the human species; that this, transmitted from man to man and from generation to generation, had necessarily acquired certain special properties—properties acquired from its contact with man in its passage through the human organism; that it had, to some extent, ceased to be animalized in order to become humanized (J. Guérin).

What pains taken to prop up original prejudices! But if, in order to possess its preservative properties, it was necessary that vaccine should first become humanized, how could horse-pox—how could cow-pox—have been

* M. Ciaudo has (*loc. cit.*) given long details of the examination of this question, which we must limit ourselves to condensing.

Dr. Pogliani (vaccine inoculations at the 23rd military depot at Milan during the first week of 1872) declares that none of the soldiers whom he had vaccinated in 1870, 1871 and 1872 with animal vaccine had been attacked with small-pox, though the epidemic raged in neighbourhoods inhabited by the men, and especially, in 1872, at the camp of Somma, where they were forced to encamp during six whole months in the midst of populations desolated by the scourge.

Drs. dell' Aqua and Graneini, of the Milanese Committee on Animal Vaccination, have published a table from which it results that, throughout the epidemic which was certified at Milan at the same period, animal vaccination was preservative in the proportion of 1·13 to 0·68 per cent., and as regards mortality as 8·45 to 6·97. Under both aspects it is thus shown to be superior to vaccination from arm to arm.

Other tables follow, equally as favourable to this theory, upon which we have glanced for a moment just to show that the results of animal vaccination are at least encouraging. The future will reveal more.

agents of preservation? And is it not obvious that, under sueh eonditions, Jenner's diseovery would have been impossible? Doubtless human vaeeine differs from animal vaeeine; but, to our way of thinking, only in its degree of virulenee. We have already stated that horse-pox is more aetive to the extent that it often enough gives rise to a general eruption, and that it loses this exeessive virulenee only by passage through a less favourable medium—the organism of the eow, for example. Then follows eow-pox, whieh naturally needs to lose a part of its intensity to aequire the qualities that make it suitable for the human organization. At this point it eeases to be able to generalize itself, with very rare exeeptions.

These are the differenees, and they are the only ones. Cow-pox loses a portion of its virulenee by eultivation on heifers, as it loses it in its passage through man. The animal vaeeine of our eultivations thus beeomes assimilated to human vaeeine; and if any superiority must be attributed to either, the supposition will not be to the advantage of the latter.

As for the notion that animal vaeeine must *borrow* something from the human organism to form the compound eonstituting so-ealled Jennerian vaeeine, it has no exeuse but its great age.

15. Onee again, it is said that the virulenee of animal vaeeine is so feeble, so delieate, that it eannot bear transport, and that it lost under the plates and in the tubes in whieh we preserve vaeeine (J. Guérin).

To proelaim that a virus is feeble, delieate, beeause it is not to be preserved under plates or in tubes, is to rush headlong into trouble and to raise opponents ready to enjoy it. The faet itself, however, was true at the time it was made a weapon of: when we fill tubes direet from

the vaccine vesicle, a coagulum very soon forms, and this coagulum is unfavourable to the manifestation of virulence, it is true. We long ago recognized that fact, and so far back as 1866 we wrote: "If we cannot find out how to delay the production of coagulum, tubes will be the tomb of animal vaccination." It was necessary then only that we should seek; we sought, and we found: in place of filling the tubes from the vesicle directly, we have, since 1867, used the method previously described. From this time we have had no more coagulum, and beyond that there was the opportunity of adding a little glycerine as an antiseptic.

Let us add that already we had found, in using dry vaccine (on ivory points), the proof that animal vaccine retains its virulence at least as long as human vaccine. To ensure this longevity it is enough to know how properly to treat the vaccine vesicle and its contents.

It has been said (Bousquet)* that the vesicles of the heifer are inferior to those of the child, inferior in duration, inferior in appearance, small, puny, with but little vigour. And from this it has been supposed that they should give us less confidence. Were the propositions true, and they are not true, the conclusion that has been deduced would not follow. Nothing is more variable than the size and the aspect of vesicles, whether they be animal or human, it is but the soil on which we observe them; it is the soil far more than the seed that gives these characters; and, to wish to argue from the shape of an eruption the vigour of its virulence, is evidently to take the wrong road. But, as we have said, these premises want accuracy, and it is because the authors have

* Acad. de Médecine de Paris. Sitting of August 17, 1869.

observed too little that such opinions have been expressed; as a general rule, it is admitted that vesicles produced either on heifers or on children with vaccine termed animal do not differ from those which humanized lymph produces; but it is by comparing vesicles produced on the same subject by vaccines equally healthy that we shall be able to establish this identity. All arguments on this head are founded on badly observed facts.

16. You will then tell us, M. Lanoix has remarked,* of the difficulty we shall meet with in procuring calves, heifers or cows to use as vaccinifers. Where in our countries is the village, however small, that does not possess these animals?

"We know how things are done in the country at present. When the public vaccinator has been able, not without trouble and often after several fruitless attempts, to develop some vaccine in a child's arm; when he has obtained the mother's consent to allow him to make use of it, it is announced by placards or otherwise in the district, in the neighbouring villages, and even in the hamlets, that on such a day, at such an hour, vaccinations will be performed.

"Frequent bad arrangements or absolute refusal of the mother, entreaties, attempts to make her give way; the necessity for the country doctor to be there on the day named, at the hour fixed; deficiency of vaccine, the impossibility of satisfying all that come; these are the difficulties. With animal vaccination, on the contrary, these obstacles disappear. The vacciniferous heifer, retained at the *station*, may be placed, for two or three consecutive days, at the disposal of the medical men of

* *Loc. cit.*, p. 125.

the neighbourhood, and each of them will be able, according to his conveniences or his need, and without fearing recriminations, to procure any supplies of vaccine that he may find necessary," and, shall we add, to vaccinate on the spot, from heifer to arm, all the vaccinable population of the place and its environs.

Let no one say, then, that animal vaccination is difficult in practice. Nothing is less true. We must accustom the mind of the public, and especially that of practitioners, to it. Let the latter arrange with the local authorities as to the details of the plan and the costs of the work, and they will realize, at but small expense, an ideal until now in vain sought after—the vaccination and revaccination of populations with *living* vaccine, free from all suspicion of diathetic adulteration.*

17. We have just seen that we must credit the

* We will cite an example showing the services that animal vaccination may render, and the small cost of such services. It was necessary to revaccinate some soldiers. Whereas in other countries, where animal vaccination is still disliked, they attempt to perform such revaccination with the aid of preserved human lymph, which originates a stock, then with vaccine from the revaccinated, whose disadvantages they would seek vainly to remedy, here, in Belgium, the following plan was adopted:—at the Military Hospital of Antwerp, where a great part of the army is garrisoned, a stable was taken, into which were passed, one after the other, a certain number of cows, kindly furnished by the military provision department, to serve as vaccinifers. Two rough tables, some expressiou-forceps, and two or three knives constituted the furniture. From the 13th to the 21st of November, eleven cows were inoculated here, and served to revaccinate 3,049 men. Only a single cow proved useless, having previously had cow-pox, of which it bore marks. The operations were not interrupted for a single day. The total result was 37·81 per cent. of successes, or 1,153 out of 3,049.

The place, the medical staff and assistants, the animals having

practice of animal vaccination with the following advantages:—

1st. It furnishes a good reserve to vaccination from arm to arm, even to the extent of being able to replace it in case of need.

2nd. By its aid we can produce an unlimited supply of vaccine matter at short notice.

3rd. We avoid all danger of transmitting syphilis from the vaccinifer to the vaccinated.

Let us see what inconveniences must be debited to it.

18. First of all, there is the danger of transmitting tuberculosis—which we know to be common in bovine races—to the vaccinated.

One fact is already established: tubercle is inoculable. Experimentally demonstrated by M. Villemin, this is already some years old, and it has recently been proved, by M. Koch's * latest evidence, that tuberculosis springs from an infection by bacteria. These bacteria, unknown till now, are characteristic, susceptible of transmission by inoculation and of being cultivated in appropriate media outside the body. They may be detected by a special method of staining: in this process, whilst all the cellular nuclei and the products of their degeneration are stained brown, the bacteria of tubercle acquire a beautiful blue tint.

The bacteria revealed by this process are motionless

cost nothing, and the latter having undergone no depreciation, the expense was almost *nil.*—Riemslagh, Army Vaccine Department. A report presented to the Minister of War. (*Archives Médicales Belges*, February 1882.)

* "The Etiology of Tuberculosis." Berlin Physiological Society, March 24, 1882. By Robert Koch.

and rod-like; they are elongated bacilli, whose length equals a quarter or half the diameter of a red blood corpuscle.

They are more numerous in parts where the tuberculous development is nascent. Free, isolated, or collected into groups, we often find them enclosed in cells. They are gathered together at the circumference of the large caseous masses. Where the acme of the tubercular action has been reached, in old lesions, these bacilli are fewer or altogether disappear. If there happen to be giant cells in the tuberculous tissue, there the bacilli abound, and in slowly advancing tuberculosis they are only to be found in them. Some of the giant cells may not contain any: these are the least recent.

M. Koch has found some of these bacilli *in man:* in *eleven* cases of miliary tuberculosis, in *twelve* of bronchitis and caseous pneumonia of which *six* had cavities, in a "solitary" tubercle of the brain, in *two* cases of intestinal tuberculosis, in *three* of scrofulous glands recently extirpated. He has established their presence *amongst animals:* in *ten* cases of acute tuberculosis, in *three* of "bronchiectasis" in the bovine class, in the caseous cervical gland of a pig, in the viscera of a fowl, and in three monkeys affected with spontaneous general tuberculosis. Besides that, he has seen them in the tuberculosis of animals that have been inoculated with the grey or cheesy tubercle of human lung, with the sputa of phthisis, with the tuberculous masses found in the lung of an ox attacked by acute tuberculosis.

Not once were the bacilli absent in tuberculous nodules from the lungs of 172 guinea-pigs, of thirty-two rabbits, and of five cats that had been inoculated. In several

instances the bacilli contained two to four oval equidistant spores.

Bacilli are the cause—tubereulosis a result. Inoculations made with tuberculous bacilli grown in cultivation liquids *outside the body* prove this. Inoculation of these micro-organisms into healthy tissues involves tubercular infection.

But there is another mode by which these bacilli located in pulmonary tubercle may be transmitted: tuberculosis shows itself in guinea-pigs, when the latter have been kept shut up for a more or less prolonged period with infected guinea-pigs, and it is through the respiratory passages that the disease advances. It seems to be the same with the monkey. "We had," MM. Dieulafoy and Krishaber state, "a little macaquo, which has lived with us for two years in perfect health. Then the monkey-house once ready and our inoculations made, we added the macaquo to the other animals, without having made him submit to any inoculation. From the very beginning of his entry into the cage this little macaquo was *protected* by a big monkey, which kept it constantly in its arms; this big monkey had been inoculated and had become tubereulous; in turn its *protégé* began to cough and get thin; it died nine days after its protector. In both these subjects we found nearly all the internal organs infected by tubereulosis." *

There is, then, to all appearance, an *inhaled* tuberculosis, and it is probable that it is the specific bacilli, escaped from the diseased lungs and fixed to particles of dust, which induce it, by penetrating into the bron-

* Academy of Medicine of Paris. "On Inoculation of Tubercle in the Monkey." Meeting of July 18, 1882.

chitic ramifications of new subjects and by proliferating there.

Inoculated tuberculosis starts from the point of entry. In the guinea-pig inoculated with a fresh portion of tuberculous tissue, the little wound is healed by the end of twenty-four hours. Eight days later a nodule shows itself, which grows without breaking, and changes into a flat dry ulcer. At the end of fifteen days the glands in the neighbourhood increase in size; the glands of the axilla hypertrophy in their turn; the animals fade away and die. Inoculation with the cultivated bacillus gives absolutely the same results. When we introduce it into the anterior chamber of the eye (Cohnheim, Solomon, Baumgarten) we find tubercular iritis develop itself. In Cohnheim's experiments the tubercular infection placed in the eye of several animals was gradually absorbed; but, at the end of four weeks, grey nodules appeared on the iris, and multiplied until thirty or forty were present. The iris became more and more swollen until it was completely infiltrated with pus. Baumgarten has pushed experiments further: he has injected into the anterior chamber of several rabbits blood taken from a recently killed animal that had been subjected to tuberculous inoculation, and, at the end of three to four weeks invariably, he has been able to show a tuberculous eruption, starting from the lower segment of the iris, the point to which the injected blood had become attached.

It results from what we have stated, that the bacillus of tubercle may transmit tuberculosis, either through a tubercle itself, or through the blood of an infected animal, or through the air exhaled by a diseased lung.

Direct inoculation of the pathological products of equine consumption may equally be made. This gives origin,

sometimes, to consumption itself; at other times to miliary tuberculosis, according to the subject inoculated.

It would be puerile to pretend to misunderstand the importance of these facts in their relations to vaccination, either human or animal. Evidently it will no longer be on theoretical grounds alone that we must base a security thus threatened; it will be necessary, in addition, to rest it upon experimental facts, which happily will not fail us.

The experience at present acquired in the matter of tuberculous inoculation discloses to us a fact of extreme importance—viz., the impossibility of inoculating tubercle by means of *superficial* insertion of its bacilli. The latter develop very slowly, and cannot, like those of "splenic blood" (*sang de rate*), rapidly infect a small wound. If we desire to make an animal tuberculous, we must carry the bacilli deeply into the tissues. Thus is it explained why it is that no one has been infected whilst making autopsies of tubereulous subjects. Thus, *à fortiori*, is it explained why no one has ever been infected with tuberculosis through vaccination.

But, it will be said, it is precisely on that point that we ask to be reassured. Ah! well, we say that, in this respect, experience has done that more than sufficiently.

In whatever fashion we may have made the inoculation, and whatever the product of which we have availed ourselves, tubereulous matter, blood or bacillus cultivated outside the organism, tubereulization has never been found at the onset: invariably the primary result has been seen at the point of entry. It is at the spot where the enemy has been stationed that it proliferates; it is there that it reveals itself by its proper produets, and not elsewhere.

It is at first—we have seen it in the guinea-pig—a nodule which grows without breaking, and changes into a flat dry ulcer, to be followed by the pathognomonic constellation; elsewhere, in the anterior chamber of the human eye, it is a tuberculous eruption in the iris, starting from the spot where the infected matter had become stationed. Is it with tuberculosis produced by inhalation that we have to do? It is in the lungs, and particularly at points where there is denudation of the protective epithelium of mucous surfaces, that the baccillus originating the neoplasm fixes itself.

We see it then always, in all its transmissions, go and come, never lost to sight. Not a link in the chain is missing. Will it be the same if we seek to explain its possible presence in the vaccine vesicle of a tuberculous subject? In theory, we may easily be permitted to say that we cannot see the microbe travelling through the tissues to infiltrate them surreptitiously, and by aid of a true diapedesis, into a vaccine vesicle produced by another microbe, and agreeing with it to dwell in a hive built by the latter for itself. Further, we cannot see these two microbes making a good mixture between them, in spite of that incompatibility of the viruses, which science is almost ready to formulate as a law.

So much for theory; now for practice. Ah! well, let them show us, amongst the millions of subjects vaccinated during the last twenty-four years, whether with human or animal vaccine, a single case that has exhibited, at the spot of insertion of vaccine virus, anything that resembled a tubercle. Nothing of the sort has ever been done, although it is probable that, amongst so large a number of inoculated persons, some must have received vaccine from tuberculous vaccinifers. What theory, what hypo-

thesis, could resist an experiment as supremely eloquent as it is extensive?

We have seen that Baumgarten had produced tubercles in rabbits by injecting them in the anterior chamber of the eye with blood from tuberculous rabbits. If this fact be confirmed, it will certainly have an important signification of a certain kind; and were the security which we feel confined to the considerations of which we have just made use, we should derive from it some reason for prudence. For all that, it would not show us that tuberculosis might be transmitted by means of serum from a tuberculous animal, a transmission which nobody has observed. It would simply involve the duty of avoiding bloody vaccinations, on account of possible tuberculosis, as has been recommended on account of syphilis. But, we repeat, the absence of any evidence establishing the possibility of originating tuberculosis by means of superficial insertion such as that of vaccination, even of tubercle itself, allows us to discard with considerable confidence the possibility of such transmission, when we have to do with products having only remote connection with it.

There exists, however, a method of placing beyond suspicion and any possible danger the preparations of animal vaccine furnished to the medical public, which consists in only delivering it to them after the animal from which it has been taken has been proved by autopsy to have been absolutely healthy. This is a precaution that should not be neglected.

19. We have also spoken of the possibility of transmitting diseases of the "charbon" type, by animal vaccination; but in addition to the fact that nothing is less common than these affections in bovine animals,

besides the fact that such a case could not escape the vigilance of the experts who visit the markets where the creatures are sold, as far as we are concerned it has been completely demonstrated, that laudable vaccine vesicles would never develop in animals affected with this constitutional disease. And there is one of the characteristic features of the question: in the vaccination of calves, we may, by the mere aspect of the vesicles, make a diagnosis of the state of health of the vaccinifer. Once the animal suffers, the vaccine papule suffers, and it is doubtful whether a vaccine vesicle could ever develop on a subject affected with charbon. As a general rule then, we ought to be able without fear to make use of vaccine taken from good vesicles; for healthy vesicles are not found in sickly subjects. We know that this is not the case in the child; a perfectly syphilized infant may furnish vaccine vesicles entirely irreproachable in appearance.

Animal vaccination then places us beyond the reach of certain mischievous influences, and especially of syphilis—influences that have brought vaccination into general discredit, which it can with difficulty throw off. From this standpoint the new method realizes an indisputable advance.

And the world has not been ungrateful. Revaccination, to any great extent, dates from the moment when, arming himself with the dictum: "If it does not do good, it will not do harm," everybody has been able, at the first threatening of small-pox, to fly to a prophylactic method which, until then suspected, in the future will exhibit only its beneficent aspects.

20. The emulation that has arisen in these latter years, between human and animal vaccine, has been the

occasion of rigorous and severe inquiry into the possible abnormal consequences of the insertion of either into the human species, each being ready willingly to admit the faults of the other. Hence, from the fact of a severity often exaggerated, perhaps unconsciously unjust, has come an unfortunate tendency to originate and ventilate in public challenges as to the real innocuousness of vaccine itself. Hence, also—and this is the good side of the situation—the establishment of their respective and actual share in the matter of criminality.

As, when sowing in virgin soil, a seed free from all admixture, we shall reap only the natural product of this seed, so if the soil conceal other roots, it will develop, at the same time as the plant desired, other plants of other species or weeds. Thus it will be with vaccination: if the vaccine germ is freed from all possibility of adulteration, and it be confided to perfectly healthy organisms, it will be able to produce on that spot, *ipso facto*, only a vaccine vesicle. But the organisms may themselves be adulterated, or endowed with exceptionally sensitive reaction; in the first instance, external manifestations foreign to vaccine may accompany or follow it, from the impulse given to organisms endowed with special predispositions, or infiltrated with principles awaiting only an impulse to evolve them.

The inoculation even of the purest vaccine may then be followed, even in perfectly healthy subjects, by various symptoms, amongst them prominently come ephemeral eruptions, destitute of determinate character, relative exaggeration of local phenomena, a phlegmonous condition of the vesicles, localized erysipelatous attacks, and sympathetically, a more or less pronounced febrile reaction. These slight complications, which we

cannot absolutely avoid, as a rule, subside spontaneously and rapidly. If we wish to hasten their disappearance, it will be enough to apply some tepid lotions, some small meal poultices, *loco dolenti*, to order some emollient drinks and a low diet. Sometimes, if the scabs have been torn off, or if the sores have been irritated by scratching, the non-cicatrized ulceration beneath becomes irritable, increases in size, may even become phagedænic, and assume large proportions. The latter hardly ever happens except in suspicious subjects, who should then be the objects of special inquiry and care. Emollients, lead lotions, applications of the nitrate of silver stick, are amongst the best measures to employ.

Erythema, scarcely called erysipelas in these cases, is often enough the result of vesicles placed too near one another, whose areolæ terminate by becoming confluent. We must, to prevent spreading, remove the cause—that is to say, the exuberance of the vesicles—which is done by applying to them early, the point of a stick of nitrate of silver. Later, we must act according to circumstances and individual indications.

Other exanthemata, destitute of importance and fugitive in their nature, may be the result of a sort of physiological impulse given by vaccination: these are—independently of generalized vaccinia—various eruptions, which mostly come under the heading of roseolæ: red spots at first becoming rose-coloured, not raised, discrete, irregular in shape, generally larger than those of measles, rather resembling flea-bites, generally appearing in summer, when the inflammation of the vaccine vesicle is most marked—that is to say, on the ninth or tenth day, coming out on the neck or face, to spread sometimes to the lower extremities, the trunk, &c. Rarely general, this

exanthem disappears in three or four days, leaving no trace and having exercised no influence on the course of the vaccinia.

"I have not spoken," says Bousquet,* "of some other little efflorescences destitute of character and danger. Physiology notes them, but therapy fails to trouble about them. We must attribute them to the sympathetic bond which unites all the organs of the human body, and more particularly all the portions of the same tissue—a sublime law, which will ever separate living from dead matter."

These end the so-called physiological accidents of vaccinia. It was necessary to point them out carefully, to separate from their account some other manifestations which may accompany it, but for which it cannot be held responsible, and amongst them eruptions eczematous, dartrous, syphilitic, &c. Here, it is the soil that is the cause and promoter of the phenomena; the seed counts for nothing.

This is of extreme importance, and allows us to bring together back-to-back, human and animal vaccine mutually supporting one another. Here is a child a few months old that we have just vaccinated with animal vaccine; all has gone well, but alas! on the eleventh day, comes an eruption of lenticular, copper-coloured spots of evil aspect. Uneasiness of family and of doctor; consultation. Inquiry as to the vaccine used, as to the lancet with which the punctures have been made. Is it the vaccine that is guilty or is it not rather an unclean instrument? These two possibilities alone present themselves. Ah! well, it is elsewhere that we must search. Show me

* *Loc. cit.* p. 194.

vaccine, animal or human, capable of giving origin on the eleventh day, in a *healthy* subject, to an eruption of copper-coloured spots; or a lancet so contaminated that it can give rise to an eruption syphilitic at the outset, on the eleventh day, without having left its visiting card at the door. We have taken note of everything, save the chief thing—the inquiry concerning the vaccinated subject and his influences.

And if we add that this same incriminated vaccine, coming from the same preparation of vaccine, taken from the same vaccinifer, has only in a hundred other persons, induced normal vaccinations, will anything else be wanting in the demonstration?

We believe it needless to add that what precedes is only applicable to vaccine *living* and deprived of blood, or to vaccine preserved under conditions which permit us to discard any idea of decomposition or putrid alteration. It will then only be a question of inoculation with vaccine, and not of that with septic matter.

Some one has said it is not possible to make in a man's skin a cut, however small, without opening a door by which death may enter. Vaccination, in so much as it is a surgical operation, is dangerous only on that ground, and it is doubtless for that reason that it has fallen into the general category.*

* But there is another aspect which we must not neglect. When the vaccine scab has fallen off prematurely, or has been torn off, an open ulcer remains, ready to absorb or collect atmospheric germs or *circumfusa*, and to be infiltrated with them; here is a door opened to many agents of irritation or infection, to inflammation, to erysipelas. Hence the necessity for surrounding the vaccinated with many precautions hitherto neglected, from the most precise cleanliness, which is not always a sufficient precaution (since it does not guard

21. Do we then pretend to conclude from what precedes, that vaccination is always inoffensive? We shall not go so far. If it has not been demonstrated to us that virulent microbiotic diseases can be communicated by vaccine lymph, as by any other natural or abnormal lymph, neither has it been *demonstrated* that such transmission is impossible, and the doubt alone should suffice to ensure at least great care in the choice of vaccinifers.

These precautions being taken, is vaccination always opportune? No; but then it is from the subject to be vaccinated that must come the counter-indications. And that is so well admitted in principle as in fact, that in England, where vaccination is obligatory, the first article in the directions addressed by the Privy Council, July 29, 1871, to official vaccinators, is thus dictated:

"Except in case of immediate danger of small-pox, vaccinate only subjects in good health. So far as regards children, be certain that they have no fever, no gastro-intestinal irritation, no skin disease; that they have no eczema behind the ear, in the groin, nor anywhere else in the folds of the skin. Do not vaccinate, unless in case of necessity, in cases where children have recently recovered from measles or scarlatina, or when erysipelas is present in the house or its neighbourhood."

against contamination with germs from outside), to the disinfection of the small ulcers by means of aseptic agents. The time is not far distant when every careful vaccinator will advise each mother to dress regularly with iodoform ointment the spots from which the scabs have dropped off, until cicatrization be complete. This will be the way to avoid erysipelas and other consecutive local troubles, which one is somewhat inclined to put down to the vaccine, the vaccinator, or the vaccinated, when *the door opened to germs* so fully explains their evolution.—E. W.

These recommendations constitute the safety-valve of compulsory vaccination. Superior to the law, there is, in the country where it exists, the authority of the doctor, who can always, on his own responsibility exempt an infant from vaccination, when he finds conscientiously that its state of health necessitates adjournment. What folly to shout then *vaccination or prison*, when the law admits of such wide interpretations.

We no longer pretend that vaccinal traumatism is inoffensive; we have said that we cannot lay open the human skin with impunity; but we do affirm that the danger is not proportional to the benefit received. And do we not each day do something which exposes us to much greater danger, with an object of incomparably smaller utility?

For example: little girls of all classes have the ears pierced to hold ear-rings, out of pure vanity in 99 per cent. of the cases. That, however, is not an act devoid of danger, since M. Constantin-Paul has been able, very recently, to collect in a single year, at the St. Antoine and Lariboisière Hospitals, 120 cases showing that scrofulous manifestations, for example, may sometimes develop in the lobula, so soon as the latter has been traversed by the ring. In this instance, says M. Paul, we have to do with benign scrofulides, eczema for example, more or less intractable and with ulcerations deforming the lobule or leaving it fissured.

We finish thus:

Vaccination is free from danger when it is practised with necessary precautions, skill and care. It is not more harmful than piercing the ears to place rings in them.

During nearly ten years the Vaccine Institute of Belgium has despatched, each year, to its representative in

London, animal vaccine for more than twenty thousand vaccinations at least. Scarcely from among this number, are three or four queries made annually concerning anomalies observed in the results following its use. And it is animal vaccine that is used. Improper vaccination may be followed by the slight accidents which we have discussed as well and even more often—who would wish to doubt it?—in vaccination complicated by the possible contaminations of the human organism.

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APPENDIX.

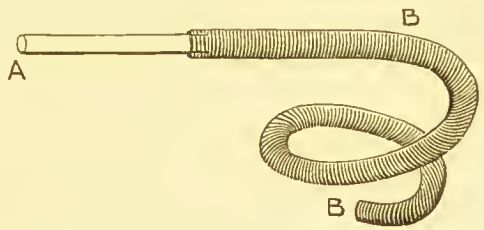
NOTE I.

As the result of some years' experience of animal vaccine, I have found that in order to secure the greatest possible protection to the subject whilst ensuring the success of the inoculation, the following scheme has been of much service :—

PRELIMINARY PROCESSES.

a. The arm is washed with an antiseptic solution, either weak carbolic lotion, or a solution (1–1000) of perchloride of mercury.

FIG. 1.



b. The surface is rinsed with pure water (distilled by preference) ;

c. Then gently but thoroughly rubbed with lint.

The selection of a well-ventilated room, free from objectionable odours or stuffiness or trace of infection, is of primary importance.

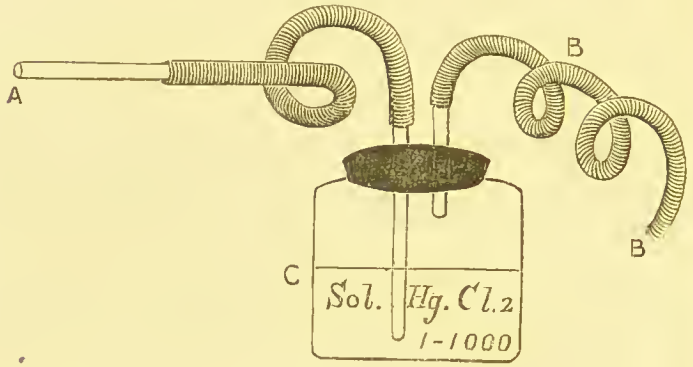
d. Scarifications, in preference to punctures, by aid of

e. A needle or "pin-point"—*never* a lancet.

f. The lymph is blown out of the "tube" with the intervention of a piece of fine indiarubber tubing (B)

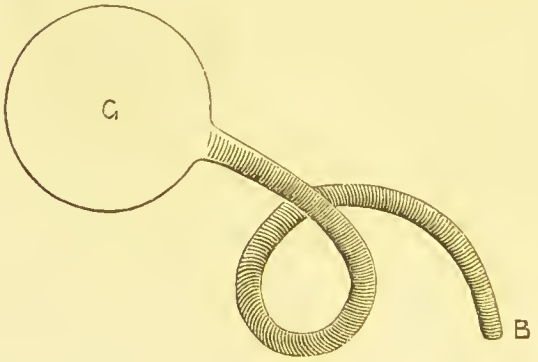
with a glass mouthpiece (A); or better, with an intermediate bottle (C) containing water or an antiseptic solution.

Fig. 2.



g. The lymph is blown out directly on to the surface of the arm, the flat end of the "pin-point" or a previously cleansed glass surface.

Fig. 3.



h. In either case the scarifications are made *through* the lymph, in other words, the vaccine is FIRST placed *in situ*, the scratching being done *afterwards*.

k. When the inoculation is accomplished and the parts dry, a pad of medicated (eucalyptus) cotton-wool is fixed in position and retained there as long as necessary.*

OBJECTS OF

(*a*, *b* & *c*) { To remove dirt and germs adhering to the surface. To excite the superficial lymphatics so as to render them actively absorbent.

(*d*) To secure as extensive an absorbing surface as may be advisable.

(*e*) Advantages of the pin-point:—The flattened head is convenient for applying necessary friction, and for receiving the lymph when blown out of the tube, and its small cost permits of its being destroyed after the operation is completed.

Objections to the lancet:—Probably used for operations other than vaccination; at any rate no one thinks of throwing away a new lancet after a single vaccination. An instrument previously used for any other case may possibly be tainted, however carefully it may have been *wiped*. As a rule, a lancet is too sharp for efficient vaccination, it cuts too deeply, and its absolutely smooth surface is not convenient for applying friction.

(*f*) The end of a "tube" being passed into the india-rubber tubing (B), the operator blows gently through the mouthpiece.

In fig. 1, a column of air intervenes between the "lymph" and the impure air exhaled from the lungs of the operator.

In fig. 2, the column of air nearest the lymph is separated from the mouth of the operator by fluid, which affords almost perfect freedom from any possible contamination.

In fig. 3, an india-rubber ball replaces the glass mouthpiece, but the use of this simple and otherwise unobjectionable apparatus entails the use of

* Dr. Warlomont informs me that the word "iodoform" was by mistake introduced into the foot-note on pp. 151, 152, instead of "antiseptic," which was intended.—A. H.

both the operator's hands, or assistance, which may not always be available.

The ball is sometimes affixed to the bottle, as in fig. 2, and here the same objections apply.

(*g* & *h*) When this is done, the operation itself involves a certain amount of "friction" under advantageous conditions.

(*k*) This preserves the site of inoculation from friction of clothes, scratching, and during the period of separation of the scab from floating germs. It also enables us to preserve the vesicle in a state favourable to the collection of lymph, and afterwards prevents the scab from being rubbed off or dropping prematurely—therefore avoiding contagion and its consequences.

ARTHUR HARRIES.

NOTE II.

DR. CORY'S EXPERIMENTS ON INOCULABILITY OF SYPHILIS BY MEDIUM OF VACCINE FROM A SYPHILITIC VACCINIFER.

In the Supplement to the Twelfth Annual Report of the Local Government Board (pp. 46–51) a detailed statement is made of Dr. Cory's four experiments. In each experiment a vaccinifer with well-marked syphilis was chosen. From these Dr. Cory himself took the lymph, and on the first three occasions vaccinated himself, on the fourth the operation of insertion being performed by Mr. Haslam. The mode of taking the lymph is described as follows:—

Experiment 1.—"He most carefully avoided, in taking the lymph, so puncturing the vesicle as to contain an admixture with blood; and in fact, had the lymph *obviously* contained any blood, he would not have used it."

Experiment 2.—"From this infant Dr. Cory vaccinated himself, taking the lymph very carefully, so as to avoid any admixture of blood."

Experiment 3.—"Again Dr. Cory took the lymph with the utmost care to avoid admixture with blood, &c."

Experiment 4.—"Although Mr. Haslam performed the operation on Dr. Cory, Dr. Cory himself took the lymph. *An ordinary lancet was used. The vesicles were shallow and*

therefore difficult to prick without drawing blood. The first vesicle which Dr. Cory opened bled, and he therefore abandoned it, *and after wiping the lancet clean* opened another. This did not bleed, lymph exuded spontaneously, but not in great quantity. It welled up into a bead, and he took it upon the lancet certainly without pressing the vesicle, and handed the charged lancet to Mr. Haslam. It is certain that the lancet was only charged once; it was not re-charged."

"Dr. Cory states that after he had been vaccinated he took some of the remaining lymph into a tube and preserved it. The lymph was only sufficient in quantity to partially charge the tube."

At the end of each paragraph describing the first three experiments are these words:—"*No syphilitic trouble followed.*"

In the paragraph marked "2" on page 49 we find:—"It is conclusively proved by Dr. Cory's experiments that it is possible for syphilis to be communicated in vaccination from a vaccine vesicle on a syphilitic person, *notwithstanding that the operation be performed with the utmost care to avoid the admixture with blood.*"

A. Pelligari's experiment (page 90) proves inoculation with syphilis by medium of the *blood* of a syphilitic to be possible.

B. In arm-to-arm vaccination it is most difficult to be positive that *no* blood is conveyed with the lymph, for *slight* contamination with blood is IMPERCEPTIBLE—

(a) To the naked eye.

(b) When examined in tubes under the microscope, except under special conditions, and by those having *special* practical experience of the examination of lymph in tubes.

(c) I this morning* examined, with the naked eye, two tubes of humanized lymph, which appeared absolutely free from any possibility of the presence of blood. Under the microscope the first tube showed two rouleaux of blood corpuscles and some separate discs, while the second tube showed numerous separate discs and a large rouleau.

* Sept. 15, 1885.

(*d*) Specimens that have been passed as *free* when in tubes by experienced general microscopists have, when blown out of the tube, often been found to contain blood corpuscles by the same observer who had previously passed them (I have in mind especially the case of a tube examined by a late demonstrator of practical physiology at a large provincial medical school, and of this tube I can give the date of collection and name of the supplier).

C. In Dr. Cory's experiment of July 6, 1881, as in the former experiments, he is *said* to have caused himself to be vaccinated with lymph "perfectly free from admixture with blood," but the report does not give us any information as to the means taken to ascertain *the positive absence of blood.*

(1) If the naked eye was relied on, its evidence is incomplete (*B*, *a*).

(2) Unless the lymph was examined microscopically by a skilled expert, the evidence is again incomplete.

In the absence of a microscopic guarantee of the *positive* absence of blood (even the minutest trace) in the lymph with which Dr. Cory was vaccinated, his experiment—valuable in itself as an example of self-sacrifice on the altar of science—furnishes *no* proof of the inoculability of syphilis through the agency of vaccine lymph. Granting that the possibilities may point in that direction, and granting also the immense importance of appreciating so grave a possibility, we are yet not justified in asserting *the fact* until it has been proved that vaccine lymph, *absolutely* free from contamination *with any trace of the blood of the vaccinifer* (guaranteed by careful microscopic examination) has been employed in a successful instance of such inoculation.

D. No syphilitic result followed Dr. Cory's three former experiments, though in the first NORMAL vaccine vesicles followed the operation in due course. If inoculation with vaccine lymph *alone* had been able to convey the disease, it would be in *this* case, where

there was absolute proof that the lymph had really been absorbed by the lymphatics, that we should have expected syphilis to follow. But no! not until the *lymph* has been taken from a vaccinifer in whom "the vesicles were shallow, and therefore difficult to prick without drawing blood," was syphilis conveyed.

E. "An ordinary lancet was used." Nothing is stated as to whether this lancet was new, or whether it might not have been imperfectly cleansed after some previous vaccination or other operation on a syphilitic subject.

"The first vesicle which Dr. Cory opened bled, and he therefore abandoned it, and after *wiping* the lancet clean opened another."

(a) The first vesicle bled easily—it, like the other vesicles, was shallow, and conversely they equally with it were prone to bleed at the slightest touch.

(b) "*Wiping* the lancet clean" is not sufficient. To have ensured the *absence* of blood, as the first attempt had drawn blood, a new instrument should have been used. Students of mycology will know that no amount of "wiping," unless accompanied by the most careful use of germicides, will suffice to render a surface, once contaminated, absolutely free from taint.

F. We are not told what was done with the "remaining lymph" which Dr. Cory preserved in a tube, but was only sufficient in quantity to partially charge it. Had this remaining lymph been carefully examined under the microscope for blood, and found free, there would have been some presumptive evidence that the portion used was also free.

G. Arguments A, B, C, D, and E apply with equal force to the cases of Professor Gaspard Cerioli (page 77) and M. Millard (page 80).

H. From the proposition that "it is *conclusively* proved blood," I must beg to dissent. There is indeed *no evidence* that the lymph used did *not* contain blood, and we are forced to the conclusion, in the absence of such evidence, that, instead of "being

free from any admixture," in all probability a proportion of blood, imperceptible to the naked eye (only) was present, and that the question of the inoculability of syphilis by means of vaccine lymph yet awaits its demonstration.

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12 PALL MALL EAST, S.W.
October 31, 1885.

THE END.

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